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Training Foundry Apprentices

How a Large Corporation, Operating a Steel Foundry Found It Expedient To Establish an Educational System with Both Practical and Theoretical Branches

BY H. A. FROMMELT

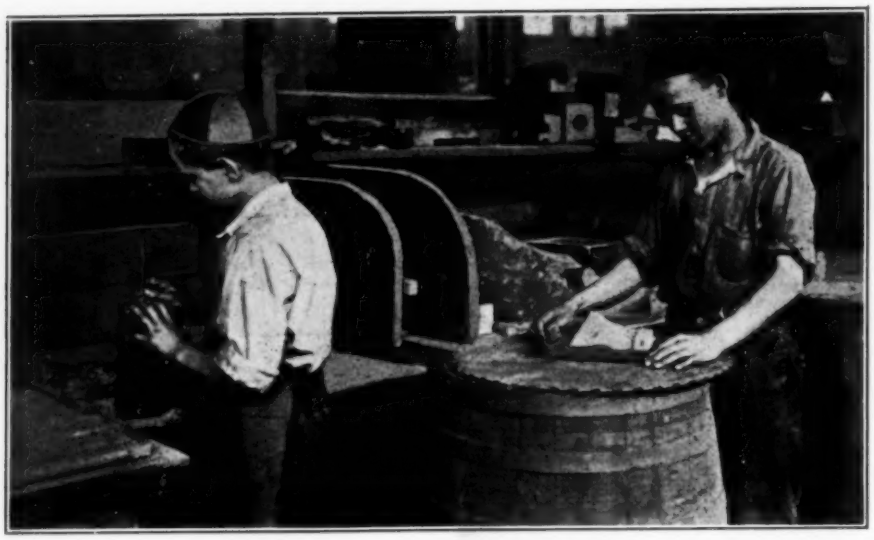
"WHAT'S the idea of that *chill?*" I asked one day when, as an apprentice, I had helped make enough car-wheel molds, it seemed, to put the earth on wheels. "Shovel, d——n you, shovel—or you'll get chilled!" That from the molder to whose tender care I had been intrusted. He was my official instructor under whose direction I was supposed not only to learn the trade, but to learn to like it! One of the few things I did learn early was the real meaning of the term **sand-rat** and how contemptible he could be. We apprentices were called **sand-mice** and if we stayed long enough we graduated into the **rat** class. The work fitted the name. We shoveled the sand, brought on the supplies and occasionally were allowed to do a little finishing; but precious little. Such was a foundry apprenticeship existent not so many years ago. It isn't surprising, after all, that the *rats* are dying out—they deserve extinction. What we need is a race of two-fisted young men who know their trade up one side and down the other and who have grown to like it because for them it is the most fascinating of all mechanical arts.

Is this impossible? No! The old gag that the modern American boy cannot be induced to enter the foundry is false. It has been used to explain the dearth of apprentices under the rotten conditions existing in foundry apprenticeships. For years past, the boy entered a shop on the supposition that he was to be taught the fundamentals of the iron or steel casting business. He was mistaken. He was wanted as a cheap sand-shoveler to some molder, probably working piecework. The management held the vague hope that he might be foolish enough to remain for four years to be called a **sand-rat.** When these conditions are righted; when a well planned course is placed before the apprentice and carried out in detail in the shop; when some of the intensely interesting details of foundry work are opened up to the eager eyes of the young man; then there is no difficulty in inducing the modern American young man to enter upon foundry apprenticeships.

In fact, a foundry aprenticeship can be made the most attractive of all the trades in the metal working industry—and it also can be made the most unattractive. Turn a young lad loose on a sand pile shoveling for a molder who *goes dumb* as soon as the apprentice lets his first curious impulse get the better of him and inside of a week, the boy sees nothing in the foundry but a sore back, the smoke and dust,

That Human Equation

TO ATTRACT the younger generation into the foundry industry and to encourage him during his training to the point that he will remain in the business is one of the main problems which today confronts the manufacturer of castings. Boys, today, are no different from those of the past, despite the finger shaking of all doddering proponents of the good old past. The solution of the apprenticeship problem revolves upon the correct answer to the universal human equation and that in turn will be found as a factor of fair, honest and sincere treatment. Boys are creatures with superdeveloped bumps of curiosity, which in its higher form is known as scientific interest. To feed that curiosity is to educate the boys, and this axiom has formed the basis for the apprentice training system established by the Falk Corp., Milwaukee. The author of this and a succeeding article is superintendent in charge of this work.



EVERY normal youngster can be interested in creative work and his interest deepens and grows as he learns the answers to his ever-ready questions of HOW *and* WHY *—These boys are typical of the younger apprentices mentioned in the accompanying article*

the heat, the *wops* and garlic. However, if you open up to him the mysteries of the sand that supports great masses of liquid steel or iron without breaking down or burning up, the intensely interesting reactions that take place in a steel furnace or an iron cupola, the mysteries of annealing and heat-treating, of risers and gates and chills the sore back is forgotten. Then, point out to him the absorbing problems involved in *rigging-up*, machine molding, material handling, foundry equipment operation and layout and he begins to love the *wop*. Show him how to figure weights, judge casting sizes, pull a test bar, pick out flaws in a casting, read a blue-print and understand the meaning of 30 point steel and he won't recognize garlic at nose-length.

Removing the Curse

All the while he is shoveling, molding, up to his neck in smoke and dirt and heat, but he has forgotten these just as a surgeon forgets the sickening details of nauseating pus or gangrene in a delicate operation. He forgets them just as the lawyer is unmindful of the revolting details of the domestic scandal or murder case on which he is engaged. No trade or profession but has its disagreeable features. A healthy young American, with a mechanical instinct and a physique for work, who cannot be interested in the steel or iron casting manufacturing business is offered an alleged, not a real apprenticeship.

The young man who approaches the Falk Corp., Milwaukee, with a view to becoming an apprentice has laid out before him a well planned course in any one of five departments. The engineering trades as they are called consist of five divisions: machine, steel, pattern, drafting and operating (or power plant). The steel division of the engineering trades consists of intensive work in the core rooms, and on the molding floors with instruction in open-hearth furnace melting, heat treating and steel inspection in addition. Thus a well rounded course is presented in four years. The primary object is to train competent steel molders. The work on the furnaces, in the heat treating and inspection departments is added to present such information as will not only make better steel molders but to arouse the interest of the young apprentice in a few of the many interesting branches of the steel foundry work. By laying before the prospective apprentice these divisions of the engineering trades an initial psychological difficulty has been overcome. To become an apprentice in the steel division of the engineering trades instead of just a molder the boy's prejudices have been overcome and his interest has been aroused by the use of a term that holds a magic spell at the present day. Behind the name lies real substance. One of the most interesting of trades is spread out fully before the young man and he is given an opportunity to make use of any or all of it.

Head Work Given

In addition to the shop work in the various departments indicated above, each apprentice gives five hours per week during his apprenticeship to work in the company class room. The course for those in the steel division of the engineering trades is designed to offer the boy an opportunity to obtain what is called the related trade technique. Brief-

PRIDE of accomplishment is an incentive in apprentice training, but the application of the recruiting slogan, Learning While Earning *is effective in maintaining interest—John Edwards, an emigrant from England four years ago, has made great strides in the molders craft.*

ly, this consists in the technical information that is necessary to train good craftsmen and also that information which would be difficult to obtain in any other manner. Like all other good things this too can easily be overdone. But if the course is carefully planned in advance and every apprentice is made to proceed according to a definite schedule it will be seen that it is impossible to present anything other than the bare essentials. Related trade technique, moreover, is but one portion of this phase of the work. English, economics, the fundamentals of modern business organization and management also are added. This work is supplemented by slides, films, lectures and occasional inspection trips. This phase of the Falk apprenticeship will be treated more at length in a subsequent article. For the moment this brief resume may suffice.

The fundamental course covers four years and is open to those who have completed a grade school education and who are sixteen years of age. A three-year course is available to high-school graduates and a two-year course to university graduates. Co-operative student apprentices from the engineering department of Marquette university form a fourth group, while a fifth group comprises adult specials who for one reason or another cannot be satisfied in any of the previously mentioned classes. In the latter group are those who have had some previous experience, but who desire to complete their training. The object is always to adapt and adjust the work to the requirements of the apprentice rather than to attempt to squeeze each individual into the same inflexible compartment.

This apprenticeship is presented strictly on its merits as a training program. At no time is there an attempt made to sell it as a money making job. The rates are fair as apprentice rates go, so that the young man who signs an apprenticeship contract is primarily interested in the instruction features of the course he is taking. The grade school apprentice in the steel division commences at 22½ cents per hour and increases by small increments every six months throughout the four years. The high-school apprentice commences at 35 cents and increases in like manner through the three years of his training. The university graduate apprentice commences at 45 cents and the last six months of his two-year course is getting 55 cents. Unless the young apprentice is interested primarily in learning this trade he will find little or no inducement in his earning powers as an apprentice. Obviously, this is as it should be. Any other arrangement would immediately classify it not as an apprenticeship, but as a job.

The machinery for executing this training program rests primarily on the foremen and instructors. An apprentice organization, consisting of an apprentice superintendent and assistants, stand back of the foremen, assisting and co-operating the work in the various departments, caring for the changes called for by the schedule and arranging the class instruction work. The foremen and shop instructors are the pivotal point about which this whole apprenticeship revolves. Unless they are vitally interested and co-operating to the best of their ability, the most elaborate training program, on paper, necessarily would fail sooner or later. Actual shop work, properly scheduled and taught is the essence of an apprenticeship of this kind. The production phase cannot ever be lost sight of, though, of course, the instruction phase predominates for a time at least. It is plain, then that the foremen and shop instructors must be made a vital part of any apprenticeship. The apprentice superintendent merely backs up the foremen, co-ordinates the work and acts as the company representative before the young learner and his parents. This at any rate has been found to be a successful arrangement in the Falk apprenticeship.

The parents of the apprentices are enlisted immediately, if possible, even before the young man begins. Modern industry, by its size, has effectively separated itself from the hearts and homes of its workers. The old contact that existed when the *Old Man* was president, manager and shop foreman must somehow be re-established. This is tremendously important in the case of apprentices. Unless the parents are made to feel a vital interest in the progress of their sons and thus aid in encouraging them over the difficulties that are bound to arise, it is safe to say that a great many will default who otherwise might be induced to remain.

The parents of Falk apprentices are visited whenever occasion demands. Monthly reports of shop work, school work, attendance, punctuality and conduct are sent to the parents. The contract or agreement is never signed until the parents have been visited or called in and the entire program thoroughly explained. In this way, the fullest co-operation between the company and the parents exists at all times.

The grades also mentioned are used in awarding prizes in each department. Three substantial prizes have been set up in each department as well as a general plant prize to which all are eligible. Thus the competitive instincts of the apprentices are aroused and the best that is in each is brought into play.

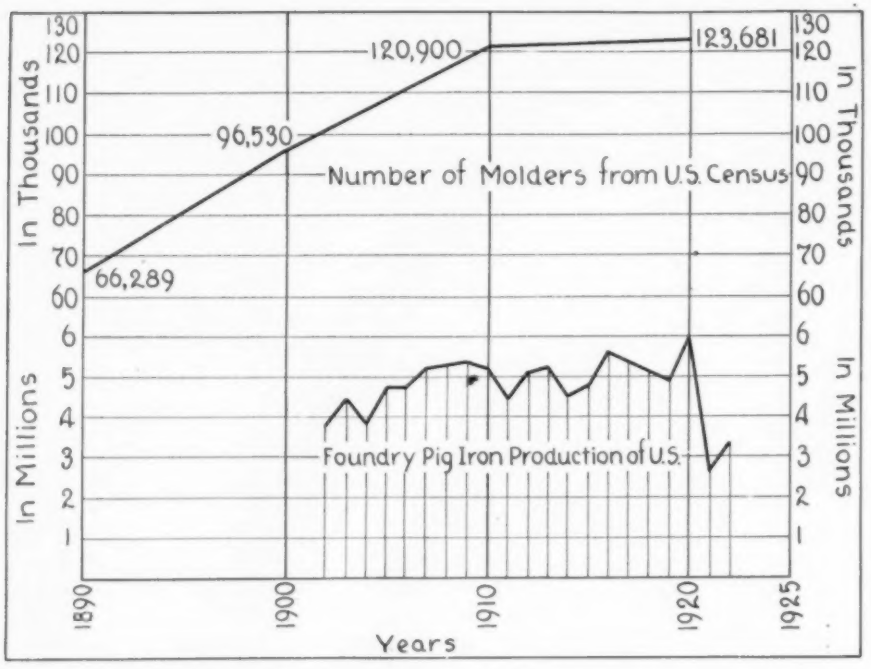
However, the essential features of this apprenticeship is a well planned course of shop work and effective class-room instruction in the fundamentals of the technique of the steel casting industry. Having this to present to the prospective apprentice makes it comparatively easy to fill the apprentice ranks in the foundry. At present about 50 apprentices are at work in the steel foundry and about 140 in the five divisions of the engineering trades. The employment roster numbers about 400 in the foundry and 950 in the entire plant. The detailed operation of the Falk apprentices training system will be given in the second section of this article which will appear in an early issue.

Demand for Apprentices Grows

BY A. TROWBRIDGE

RECENTLY an effort was made by the National Industrial Conference board to collect some statistics on the subject of the foundry apprentice. It was considered advisable to study what was being done with a view to increasing the number of young men training for foundrymen. Twenty-five foundrymen replying to these letters stated that they employ no apprentices at present and most of them added that they had employed none for some years. Of course such a condition is leading the industry straight toward trouble. Little imagination is required to picure the difficulties that will arise when the present generation of skilled men has disappeared, if the coming generation has not been trained in the way of real molders.

The machine industry underwent a similar upheaval to that now taking place in the foundries. The introduction of machines capable of turning out a number of duplicate parts more or less complete resembled the present introduction of molding machines into the foundry. The demand for skilled workmen was reduced temporarily but eventually it was found that not only many skilled men were needed but a considerable proportion were



FACTORS HAVE UNITED IN SUCH A WAY THAT THE AVAILABLE SUPPLY OF SKILLED MOLDERS HAS BEEN TEMPORARILY SUFFICIENT

required to have a higher degree of skill than had been customary under previous conditions. The development of mechanical appliances in the foundry undoubtedly will show a similar need of increased knowledge and skill in that work.

Changes in the kinds of material used for manufacturing purposes are cutting into foundry work and reducing the number of skilled men required. Increasing use of stampings and rolled or forged steel also makes a serious reduction in the number of castings needed. A number of factors have united to make the available supply of skilled molders temporarily sufficient. Statistics regarding foundry pig iron produced in the United States indicate that the amount has been rising steadily for the 20 years through which statistics are available. This means a greater number of castings turned out and proves that the foundry business is not disappearing even though no new molders are being trained. Statistics indicate that the day rapidly is approaching when shortage of skilled men will place great power in the hands of the few remaining.

Variety Offered

Last year the National Metal Trades association issued a plan for apprentice training in the metal industries. This applies only to machinists, but in a general way could be adopted for patternmakers and molders. Naturally, the details of the course would be different but the general terms covering the agreement and plan of instruction would be applicable. One of the features of this plan which undoubtedly could be adopted to good advantage in the foundry, is the arrangement for shifting apprentices from one shop to another so that their training may be complete and properly balanced. Work done by the apprentice should be graded in a manner to become increasingly difficult to hold the interest of the worker. In many shops, particularly those producing a large percentage of repetition work, not only would this progression be hard to arrange but it might be impossible to find a sufficient variety of work to adequately teach the trade. By adopting the scheme of shifting the apprentice from shop to shop and by including a few months' work in patternmaking it would be possible to turn out a real molder.

Where proper facilities are offered, advantage could be taken of the public school system. Public school instruction usually is not as satisfactory as that given in special schools conducted by men chosen for their fitness not only to teach the subjects covered in the books, but also able to correlate this to the shop work.

Undoubtedly the day has come when school hours are to be counted a part of the apprentice course. To those who have not considered paying apprentices for the time spent in the school room it seems as if this would be a serious burden. It is interesting to note what already has been done along this line. In England the Fisher education act passed in 1918 requires compulsory attendance at school of all young people up to the age of 18 years for a given number of hours per week. If they are employed, the employer is compelled to pay their wages while in school, which must begin not earlier than 8 a. m. and end not later than 5 p. m. Wisconsin has passed legislation of a similar character, though not quite so drastic, and indications are that other states will take similar action. The New York Building Trades council last year put into operation an apprentice training plan involving attendance at school and specifying that he should be paid for such time.

Earning While Learning

The question of pay is the most important item in this matter of attracting apprentices to the foundry. A boy will take that employment which he thinks is going to pay best. If he finds that he can make from 25 per cent to 300 per cent more at other trades, it is difficult to induce him to work in the foundry. If the trade is to be made attractive to the prospective apprentice he will have to be paid reasonably good wages. Also a course must be planned which will not only teach him the mechanical part of the trade, but will give him a sufficiently good general education so that he may have a reasonable expectation of rising to a position of responsibility. High wages are not the only attraction to a young man. Many other things may appeal to him, but unless a way can be found to appeal to his imagination the foundries will not get enough apprentices.

Recruits must be offered more than a mere job. Don't hire a boy and simply turn him loose in the shop. Why not do as the navy does and let him learn while he earns? Why not give him an education as well as a trade? Possibly one of the best things that could be done would be to form, wherever possible, a group of co-operating foundries that would take a number of apprentices proportionate to the number of molders employed and have a joint school located as conveniently as possible, where all the boys would be given an education. The studies included should cover not only reading, writing and arithmetic but their application to the things that the boy meets in everyday life. He should be given some instruction in government, shop management, elementary chemistry, physics, metallurgy and also bookkeeping. This last subject will help the

boy realize that direct labor is not the only expense of manufacturing and, consequently, will enable him to better understand the relation of management and men. By having an agreement among the various shops in the group to shift the boys from shop to shop the boys would get a better chance to learn the trade and a noticeable improvement would be noted among the foremen.

One thing from which the foundries always have suffered has been the quality of men employed. Due to the fact that so many entered as helpers we find a large number comparatively ignorant. In taking on new apprentices it would be advisable to announce that only high grade boys would be accepted. This at once gives a certain standing to foundry apprenticeship which it has not had heretofore. All candidates should undergo a careful physical examination. Work in the foundry usually is heavy and it is not advisable to attempt to train any boys who are not physically sound.

Instructors for the school work if possible should be chosen from among the foremen or workmen in the trade. By this arrangement the relation of the studies to the work can be brought out. This has been found to work exceedingly well in training apprentices along other lines. In case the facilities offered by public schools are used, the foundries should supplement the instruction given in the school by special classes designed to tie together the school and shop work. In other industries it has been found necessary to shorten the period of apprenticeship considerably and give a great deal of the shop instruction in a special school. This is particularly true of the printing crafts. Where possible, there is great value in carrying on work in this way because it gives the boys such a fine opportunity to assume a certain amount of responsibility during their training course. While the special school may not be possible for the foundry, it is recommended that careful thought be given to the suggestion of intensive training so as to shorten the time of the apprentice course as much as possible. On the completion of the course, each graduate should get a diploma or certificate issued by the national association to form a climax to his attainment.

Familiarity With Sweeps Valuable Asset

BY M. E. DUGGAN

WHEN a casting in a piece of machinery breaks in service and a pattern is required before it can be replaced, a blue print, a free hand sketch, or, in some cases, the broken casting itself, is rushed to the pattern shop. Before the patternmaker has had time fairly to size up the job he is asked to furnish an estimate on the probable time required to produce a casting. This is a difficult question to answer, especially if the pattern is complicated, requiring a great deal of time in its construction and if the patternmaker is expected to follow the drawing literally, or to reproduce the casting in its most minute detail. Many little points in construction and elaboration of detail in the finish and appearance are perfectly justifiable where the product is to be made on a quantity basis, but have no place on a hurry-up job where the utility of the finished casting is the only important factor.

The man who accompanies the broken casting, or who brings the drawing to the pattern shop, may be a draftsman, with only a superficial knowledge of pattern shop and foundry requirements. He may be connected with the mechanical department, or perhaps a department foreman, or in fact any one of a number of positions, which does not qualify him to pass judgment on what may and what may not be omitted from the pattern without impairing the usefulness of the resulting casting. In many cases the foreman patternmaker through age, experience and training, is qualified to make all the necessary changes on his own initiative, but usually it is safer to have some person qualified to speak with authority, to either suggest, or O. K. the patternmaker's proposal.

Even where a drawing is available, it is advisable to also send the broken casting to the pattern shop. It is difficult in many cases to show a complicated design in a way that may easily be read and understood by the patternmaker. Some patternmakers are quicker than others at interpreting a drawing. Those in the slow but sure class, usually may be relied upon if given plenty of time, but when pushed, are liable to make mistakes on account of starting before thoroughly understanding just how the pattern and coreboxes are to be constructed. Sight of an old casting is a distinct advantage either to a slow or a fast man. The parting lines on the old casting will furnish a valuable guide on how it was molded. The presence of an old, or broken casting, on the floor, or bench, eliminates guess work and prevents many mistakes that are not only possible, but exceedingly probable, when working from a complicated drawing.

Frequently when a rush pattern is required the patternmaker is asked to make a set of sweeps and coreboxes instead of a whole pattern. The practice saves labor, lumber and time in the patternshop, provided the patternmaker is a mechanic who understands this branch of patternmaking and molding practice. The only practical method of becoming familiar with the use of sweeps and coreboxes is to visit the foundry and watch their application. One actual demonstration in the foundry will teach a man more than a dozen lectures. Usually all work of this character is entrusted to one man, but there is no reason why the other patternmakers in the shop should not familiarize themselves with the details. The following is a fair example of what sometimes happens when a man not familiar with the method attempts to make a set of sweeps and coreboxes.

To replace a broken gear 6 feet diameter, 7 inch face, 6 arms, with cut teeth, it was decided to sweep the rim and form the arms in cores. The patternmaker apparently made no allowance for the 2-inch spindle when laying out his diameter line and the result was that when the casting arrived in the machine shop it was found to be 2 inches too large in diameter. To machine the extra inch off the face would leave the rim too thin. A council of the men interested was called to decide whether to scrap the casting and make a new one off the corrected pattern outfit, or to find some way in which the existing casting could be adapted. Under ordinary circumstances the casting would have been thrown out without any consideration, but the mill was shut down in this instance and every minute counted. Finally it was decided to use the wheel by laying out a new tooth circle, adding the necessary number of teeth and then move the pinion back on the frame a sufficient distance so that the teeth would mesh properly with the enlarged gear.

Arc Furnace Operation Flexible

Six-Ton Ludlum Electric Furnace Installed for the Production of Steel and Iron Castings and Melting Down Nickel Steel Scrap—Problems in Locating, Equipping and Operating the Furnace Are Considered

BY J. L. McK. YARDSLEY

PROBABLY few installations have provided more opportunities for the electric arc furnace to prove its flexibility and adaptability under changing commercial conditions such as affect the operating requirements of a steel melting plant and foundry than has the 6-ton ludlum furnace installation at the Trafford foundry of the Westinghouse Electric & Mfg. Co. This furnace, which was first placed in operation February 27, 1920, was installed through the foresight of A. Slusser, foundry manager, who in addition to desiring to turn into ingots a large tonnage of nickel steel scrap on hand and to take care of rush orders for castings which custom foundries were unable to deliver in time, anticipated considerable growth in the electric steel foundry business as a whole.

The author, J. L. McK. Yardsley, is general engineer, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Conditions Hamper Furnace

It was realized at the outset that any single electric furnace installed in the Trafford works, which was built, organized and operated as an iron foundry, would be handicapped by local conditions in a way which would not occur in a steel foundry especially laid out for the purpose. However, it was concluded that these conditions would not be so seriously detrimental as to jeopardize success as a commercial installation, through causing prohibitive operating costs. Some of these conditions which existed are worth discussing, both as an aid in interpreting the results obtained in this particular installation and as a guide in determining what should be the best conditions to produce the ideal situation in the especially designed electric steel foundry which was contemplated. The furnace bottom, as built, had only 6 inches of magnesite over a 9-inch brick lining and the furnace had an actual capacity of over 8 tons. In the location where it was necessary to place the furnace, it is on the pouring floor level. It is accessible to only one of the two cranes in the furnace bay, and the resulting necessary location of the furnace

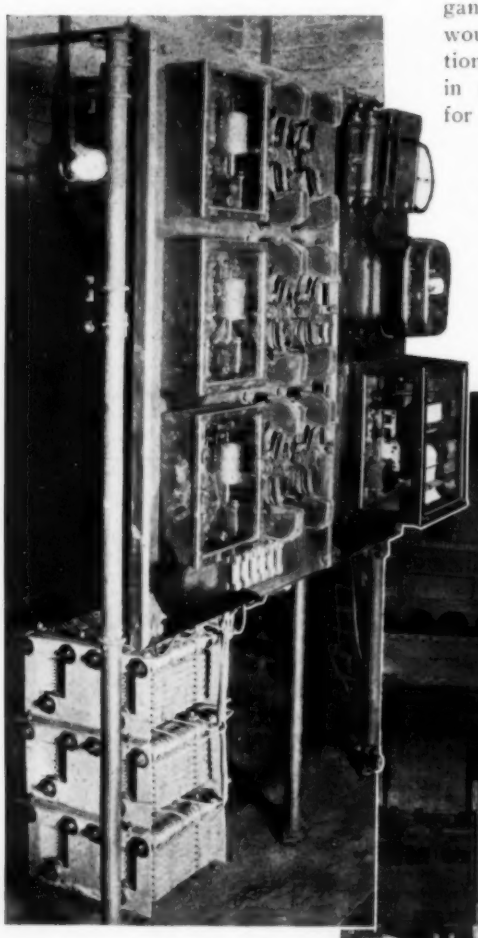


FIG. 1—THREE-PHASE AUTOMATIC REGULATOR FOR ELECTRIC FURNACE TOGETHER WITH INCOMING LINE METER PANEL

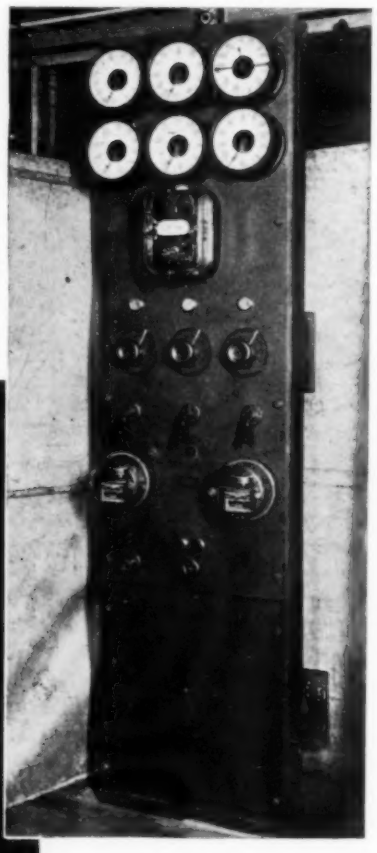


FIG. 2—CENTER—THE INTERLACED BUS COMES TO THE FURNACE FROM THE FLOOR ABOVE FIG. 3—SWITCHBOARD PANEL WITH CONTROL EQUIPMENT

transformer causes unusually long secondary leads.

With small furnaces, where the metal is shanked out directly from the furnace in hand ladles, location of furnace on the pouring floor level is unavoidable. Where the metal is handled by crane ladles many points favor setting the furnace on a raised platform, of sufficient height to obviate the necessity for a deep ladle pit in front of the furnace, and of sufficient area to make furnace operations as convenient as possible. This setting has a number of advantages:

It keeps the furnace crew away from the molders.

It makes possible the mounting of tilting motors and machinery out of the way of chance injury by vagrant hot metal or water. The Trafford furnace was shut down for several days at one time due to the flooding of the pit.

It cuts time in all operations of the ladle at the furnace, and also makes for easier slag disposal.

As disadvantages, this setting requires that:

A more expensive structure be provided. The whole building must be higher to allow the cranes to pass over the furnace.

All materials must be carried up to the platform. The space under the furnace is not waste, however, as it conveniently can be used for the storage of furnace materials.

Accessibility and adequacy of material handling equipment is essential in order that operations will not be hampered. Where the hot and cold metal are both handled by crane it is important for quick operation that more than one crane be available for work at the furnace at times of pouring and charging. This is particularly important where castings are poured directly from the crane ladle, and where a crane is also required in charging the cold metal, either due to the size of scrap used or to the fact that top charging from preheated bucket is employed.

Crane Recharges Furnace

In one custom foundry, where the crane ladle filled with hot metal from the furnace is quickly deposited upon a car, for transfer into the pouring floor bay where it is dumped by crane into a number of hand ladles, the furnace crane immediately picks up the bucket containing the new charge consisting of 5 tons of steel scrap, which has been preheating with oil, and takes it to the furnace where it is lowered through the opened top and emptied. The whole operation of pouring and recharging the furnace consumes not more than 15 minutes. Power is on the furnace from 1 hour and 35 minutes to 2 hours per heat. The maximum 5-minute power demand is limited to 1500 kilowatts. Five heats are poured during the 10-hour operating day. The average power consumption is 460 kilowatt hours per ton of steel melted. From 20 to 70 heats are obtained per roof.

FIG. 4—POURING FLOOR, SHOWING WORK IN COURSE OF COMPLETION—NOTE THE HEAVY STEEL FLASKS

With conditions existing at the Trafford works, where fortunately the furnace and pouring floor are in the same bay, really speedy operation at the time of pouring and recharging the furnace with the grades of scrap employed only can be accomplished by transferring the hot metal ladle from the furnace crane to the pouring-floor crane and allowing the former to turn at once to the work of charging the heavy scrap. The present average time of 1 hour and 15 minutes consumed, of course, would be reduced materially were light scrap, such as is easily shoveled by hand, used entirely or a charging machine provided, and could the practice of patching furnace bottom after every heat be changed to every two or three heats, or every day.

Only second to the location of the furnace with regard to shop operation and the other points discussed is the importance of locating the electrical equipment with relation to the furnace. Space was not available at the pouring floor level for the transformers and other equipment except furnace control panel owing to the fact that the power supply is at 22,000 volts. Power was purchased from the Duquesne Light Co. on a 15-minute demand. (in accordance with schedule *F*). It was necessary to place lightning arresters, incoming line circuit breaker and tap changing switch, metering panel, automatic regulator, and the 2000-kilovolt-ampere, 3-phase furnace transformer on a gallery 22 feet above the pouring floor level. This introduced problems in connection with getting power to the furnace which demanded special attention in the general consideration of a suitable layout.

The furnace manufacturer required that the furnace transformer be connected in star on the secondary side so that the neutral could be carried to the furnace shell. Voltages of 120 and 105 at full capacity, and 90 at reduced capacity, were specified. As indicated, Fig. 2, it was necessary, to make provision to carry a current, reaching 11,000 amperes at full transformer rating, a distance of approximately 43 feet per phase from transformer terminals to furnace electrodes. Power schedule *F** required that this be done in such manner that high tension power factor would be at least 90 per cent, in order to give freedom from liability of penalty. It actually developed that this requirement was less difficult to meet than it was to do the job economically; that is, without appreciable efficiency loss due to use of an excessive amount of copper.

Reliability Essential

Since the purpose of the electrical equipment is to faithfully serve the furnace and enable it to produce steel at lowest possible power cost, reliability is the essence of the installation, and ruggedness and simplicity of construction and accuracy of control must be its chief characteristics. Switchboard details should not cause annoyance and delay. Controller handles should be substantial, easy to hold with sweaty hands and, where indication of controller position is necessary, it should be made obvious from a considerable distance away from the switchboard. Attention should be given to the visibility of meters from operating positions of the furnacemen. The rear of the control panels must be protected from dirt, dust and mechanical injury amid the strenuous operations of the steel plant, and yet must be readily accessible in case of need. The graphic wattmeter

*See *Forging and Heat Treating*, March, 1921, and *Blast Furnace and Steel Plant*, June, 1921.

should be located away from access by the furnace operators, preferably in the superintendent's office, as it is a most valuable check on operations. At Trafford the graphic wattmeter was placed on the metering panel in the transformer vault on the gallery as shown in Fig. 1. The automatic furnace regulator is shown in the same illustration. As this piece of apparatus is so vital in any successful electric arc furnace installation, it deserves greatest consideration of all.

The regulator for controlling the movable electrodes was built by the Westinghouse company. The regulating equipment consists of two parts, the control panel and the regulator panel.

Fig. 3 is a view of a switchboard with control equipment.

The regulator panel contains the control element, the magnetically operated switches which control the electrode motors, the necessary switches and fuses with resistances and capacities mounted back of the panel. The control element consists of a pivoted lever, floating in horizontal position with one core at each end extending into solenoids. The pull of one of these coils varies with the current which flows through the corresponding electrode, while the pull of the other coil varies with the voltage between the electrode and bath, or between two electrodes on a free burning arc furnace. The pivoted arm has one set of contacts at each end. These contacts are so arranged that they control magnetic contactors which in turn control the electrode motors. With power off the furnace this lever remains in horizontal position. On closing the main breaker, potential is immediately established between each electrode and the furnace charge. The voltage coil becomes energized and pulls its core up, thereby closing the contacts on this end of the lever, which in turn closes the contactors, operating the electrode motor in direction to lower the electrode continuously and at full speed until it makes contact with the charge.

As the voltage coil is connected between the electrode and the furnace charge its current will be shunted and it will become de-energized the minute the electrode makes contact with the charge, thus allowing the lever of the main control element to return to its horizontal position and open the motor circuit. As soon as the circuit has been completed by another electrode having made contact with the charge, the current coil becomes energized thereby closing the contacts which cause the electrode motor to raise the electrode, thus drawing an arc to the bath. The motor continues to raise the electrode until the voltage between the electrode and the charge increases and its current decreases to such an extent that the pull of the voltage coil is equivalent to that of the current coil. The lever will then assume a horizontal position, opening the motor circuit. Any disturbance of the equilibrium between the pull of the coils due to variations in the arc will cause either contact to close, thus operating the electrode motor in a direction to compensate for the disturbance. A current adjusting rheostat is connected across the current transformer and by changing its position, the value of the current per phase, for a given current in the current coil of the element, can be altered at will, within the limits of the apparatus.

T-3001

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.—TRAFFORD FOUNDRY

ELECTRIC FURNACE REPORT "Basic" Operation

CHARGE	Lbs.
Cast Iron Millings	18036
Total	18036
METALIC ADDITIONS (PER CENT CARBON / PER CENT ALLOY)	
Carborite	
Fe. Mn.	
" Si.	
Total Metal in Furnace at Tap	18036
Electrodes	
Roof	
Furnace	
Doors	

SHIFT Day | DATE 1/6 1921 | GRADE Cast Iron | HEAT No. 158

ANALYSIS	T.C.	C.C.	Mn.	Si.	P.	S.	Cr.	Ni.	W.	Va.	Gr. C.
Specified											
Final	3.65	.92	.46	2.03	.512	.040					2.73
Figured											
Preliminary 1											
" 2											
" 3											

	Melter	Time	Meter Reading K. W. H.	Hours For Heat	K. W. Hours Total	K. W. Hours Per Ton Melted	K. W. Hours Per Ton Good Cast	K. W. Hours Extra
Start Charging								
Power On		10.25	839400					
Skim								
Tap		2.40	845500	4.15	5600	625		

Slag Materials		Weight Report		Castings Report		
	Lbs.		Lbs.	No. of Pieces	Size	Total Weight
Lime	100	Gates and Risers				
Fluorspar		Rejected Castings				
Carbon ~~Coke~~	432	Dolts				
Fire Sand or Ore		Sullys				
		Pit Scrap				
Refractories		Total Scrap				
Magnesite		Accepted Castings				
" Cement		Total				
Clay		Total in Furnace at Tap	18036			
Sand		Difference				
Nozzles						
Stoppers						
Sleeves						
Tiles						

FIG. 5—LOG SHEET OF A HEAT OF CAST IRON MADE WHEN THE BASIC LINING WAS IN THE FURNACE

The regulator can be adjusted to operate when the current varies 5 per cent from its normal value. The utilization of both arc voltage and arc current for controlling the electrode motors prevents the electrodes from getting into the steel under automatic regulation. The regulator is particularly rapid since an electrode speed of 2½ to 3 feet per minute is possible under automatic control. Current surges are brought back to normal with a promptness which results in a reduction in the demand load, especially when a short demand period is the practice of the power company. The speed with which settled conditions are attained reduces the overall time per charge and permits a greater production of metal per hour. The regulator operates at full speed until current is within about 10 per cent of normal and from there on its speed tapers to zero as the current reaches normal. This zoning effect

is accomplished by means of auxiliary contacts on the main contactors which operate to short circuit sections of the voltage and current coils of the regulator respectively. High speed insuring close regulation is thus obtained without overshooting or hunting.

It was the practice in early installations to control the position of electrodes manually, to obtain as nearly as possible constant power input. This manual regulation required the unceasing attention of one or more men per furnace, depending upon the number of electrodes. An automatic regulator almost entirely relieves the furnace crew from attention to the regulation of the furnace, and allows them to give practically their entire attention to the metallurgical aspect of melting steel and producing hot metal. This results in a reduction in the number in the crew, particularly if several furnaces are charged and tapped in rotation.

Product Determines Lining

Actual operating methods depend upon foundry requirements. Whether the furnace lining is to be, or should be acid or basic, is one which is so essentially tied up with the kind of product to be produced, and with the economics of every installation, that it must be given careful consideration. It is usually considered cheaper to operate an acid electric furnace than a basic, taking account of power and electrode consumption, refractory costs and greater production. However, in practice, this is largely offset by the high price of guaranteed melting stock.

The lining of the acid furnace is built of silica brick covered on the inside with ganister or silica sand sintered in place, and it may be readily patched. The lining of the basic furnace consists of magnesite brick with a bottom of burned magnesite sintered in place, or tamped with tar. The basic lining is the more expensive. The choice between the two depends upon whether quantity production or steel of definite and highest quality is desired. The writer is of opinion that better steel can be made by the basic process than by the acid process. It is extremely difficult in the latter to make alloy steel with guaranteed results, because the alloys themselves oxidize quickly. In adding alloys in the ladles, it is difficult to obtain uniform results. In basic practice, the alloys may be mixed in the furnace. In some respects, the basic electric furnace is like the basic open-hearth furnace. However, it is superior to the open hearth, because of the uncertainty of sulphur elimination in the open hearth. One difficulty in basic electric furnace practice is the tendency of slag to get into the mold, with top pouring. However, the danger of effect of this upon the steel can be largely overcome by bottom pouring. Finally, whether the lining shall be acid or basic is usually decided upon consideration of certain definite factors. The acid lining is used when:

The sulphur and phosphorus in the scrap employed is, and is likely to continue to be less than the sulphur required in any castings to be made.

The range of manganese and silicon requirements of the castings will not be too exacting.

Close limits are not set for physical tests.

Power consumption must be low and rate of operation is of prime importance.

Small castings in quantity production are to be the sole output.

Determine Basic Operation

Basic operation is determined upon when the first three of the foregoing conditions are opposite to those indicated, and when:

Alloy steels are ever to be made in the furnace.

A steady load is essential.

Refining of cast iron is being considered. In making engine cylinders, high pressure valves, piston rings and parts requiring uniform wearing qualtities, a practice now being adopted is to pass the molten iron from the cupola through the electric furnace for a refining period of from 20 to 40 minutes. This gives a rapid desulphurization, elimination of occluded gases, and an accurate pouring temperature.

Considering all these things, it is interesting that during its more than two years of service, the Ludlum furnace installation at Trafford has successfully operated for different lengths of time on the following work:

With a basic lining—

T-2001

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.—TRAFFORD FOUNDRY

ELECTRIC FURNACE REPORT Basic Operation

CHARGE	Lbs.
Turnings	1820
Steel	1710
Sprue Returns	7210
Steel Charging Scrap	2430
Total	13170

SHIFT Day | DATE 7/8 1921 | GRADE Steel A, B, C & D. Rail Castings | HEAT No. 1117

ANALYSIS	Cast	C	Mn	Si	P	S	Cr	Ni	W	Va
Specified		.20/.30	.40/.55	.20/.35	.05	.05				
Final		.23	.48	.28	.027	.028				
Pressed		.21	.65	.30						
Preliminary 1		.08	.42		.028					
" 2		.12	.42							
" 3		.21				.027				

	MELTER	TIME	METER READING K. W. H.	HOURS FOR HEAT	K. W. HOURS TOTAL	K. W. HOURS PER MELTING TON	K. W. HOURS PER GOOD CAST.	EXTRA
Start Charging								
Power On		6 AM	983600					
Sash		8.30 "						
Tap		9.50 "	988300	3.50	4700	700		

METALIC ADDITIONS PER CENT CARBON	PER CENT ALLOY		
		Carburite	42
6	76	Fe. Mn.	109
	50	" Si.	108
Aluminum			3
Total Metal in Furnace at Tap			13432

SLAG MATERIALS		WEIGHT REPORT	Lbs.
Lime	800 Lbs.	Gates and Risers	
Fluorspar	102	Rejected Castings	
Carbon-Coke	72	Butts	
Fine Silicon	55	Skulls	
Ore	150	Pit Scrap	
REFRACTORIES		Total Scrap	
Magnesite	250	Accepted Castings	
Grinding Sand	125	Total	
Clay	200	Total in Furnace at Tap	13432
Sand	200	Difference	
Nozzles 1-1/4	1	Slag skim	400
Stoppers	1	finish	735
Sleeves	6		
Tiles			

CASTINGS REPORT	No. of Pieces	Size	Total Weight

Electrodes New on #1 (6"ϕ 10"D-280 lbs)
Roof OK
Furnace "
Doors "

FIG. 6—RECORDS OF HEATS OF STEEL MADE IN THE FURNACE UNDER BASIC OPERATION

Melting down nickel steel scrap and refining to form ingots.

Melting down miscellaneous steel scrap and refining to form steel castings.

Melting down cast iron borings and turnings to form iron castings.

With an acid lining—

Melting down selected steel scrap to form steel castings, operating at approximately 115 volts, and also at approximately 128 volts.

The first 19½ months of service the furnace was operated with basic lining. One hundred and thirty-one heats of nickel steel, six heats of cast iron using cold scrap and one heat of cast iron using hot metal from the cupola were poured. Then 492 heats, melting miscellaneous steel scrap and refining for steel castings were made with average power consumption of approximately 725 kilowatt hours per ton. Steel castings were produced according to four different specifications as follows:

Specification *A* is for soft steel castings to be thoroughly annealed. Composition: Carbon 0.20 to 0.35 per cent, manganese 0.50 to 0.80 per cent, phosphorus not over 0.05 per cent, sulphur not over 0.05 per cent, silicon 0.15 to 0.35 per cent.

Specification *B* requires a good commerical grade of castings containing not over 0.30 per cent carbon nor over 0.08 per cent phosphorus.

Specification *C* calls for a high grade of normalized steel casting. The castings are allowed to become cool and then are uniformly reheated to the proper temperature to refine the grain (approximately 925 degrees Cent.). They are then drawn from the furnace and allowed to cool in the air at the ordinary shop temperature, protected from moisture and draft.

No physical tests are required for Specifications *A*, *B*, and *C*. The following requirements are included: Surface inspection before and after machining; castings true to pattern within commercial limits and all the cores accurately placed; castings free from all injurious defects; bearing surfaces solid and without porosity in positions where the value for the purpose intended would be seriously affected by porosity; gates and risers neatly and closely trimmed; and castings free from sand, scale, etc.

Physical Tests Not Required

Specification *D* covers large annealed steel castings. The castings are left in the mold until entirely cooled to 700 degrees Cent. The castings are annealed by being heated slowly and uniformly to proper temperature to refine grain and held at this temperature sufficient time to insure complete penetration, then allowed to cool uniformly and slowly.

The following physical tests are required: For the tension specimen a bar ½-inch diameter with a 2-inch gage length is used. The bend test specimen is ½ x 1-inch section. Both are machined from a test coupon 1¼ x 1¼ x 5 inches after removal from the casting. The requirements are a tensile strength of 60,000 pounds per square inch; yield point by drop of beam, 27,000 pounds per square inch; elongation in 2 inches, 22 per cent; reduction of area 30 per cent.

Provided With Acid Bottom

Business depression shut the furnace down Oct. 14, 1921, for 14 months. When conditions permitted starting again steps were taken to reduce operating costs. It was found possible to buy at reasonable price turnings and light charging scrap of composition which would analyze before charging under 0.04 per cent phosphorus and 0.04 per cent sulphur. The furnace was accordingly lined for acid operation, it being considered that the greatest savings could probably be accomplished by increasing the number of heats per working day and reducing the kilowatt hours consumed per ton of steel produced. The bottom was made by sintering 9 inches of silica sand over 9 inches of silica brick. The furnace was started Dec. 20, 1922 with acid lining for heat No. 631 to make steel castings according to specification *D*, working upon charges consisting of:

Heavy charging scrap—foundry returns. Light charging scrap—plate shearings, small forging stock, 3-inch shells. Turnings—heavy short shovel turnings.

The four reports shown in the accompanying tables are typical of the four periods of operation. The first 60 heats with the acid lining were melted with too low an applied furnace voltage. As a result the heats were of unequal and uncertain length. Owing to condition of scrap and method of charging, high resistance due to nonconducting material under the electrodes caused great difficulty in getting current through the charge at the beginning of a heat. In time the three graphite electrodes of comparatively small diameter and arranged in a row, would cut a narrow trough down through the metal, establish a logitudinal pool and finally heat and melt the entire mass of metal. Power consumption was practically as great as with basic operation and electrode consumption was higher, being around 17 pounds per ton. Electrode cost at 18 cents per pound was therefore $3.06 per ton.

The applied voltage was then increased to the maximum obtainable from the transformer and greater care was observed in charging. Markedly improved results were at once obtained. Electrode consumption was reduced to 8 or 9 pounds per ton. That is, on the average, one 60-inch by 10-inch diameter section was added every fourth 8-ton heat. More than 200 heats have been poured under the improved conditions.

The following is a summary of the cost details in the steel melting department, showing the cost of steel at the spout and in the casting for Feb. 1923.

Miscellaneous alloys, 22,467 pounds	$531.00	
Scrap, etc., 956,420 pounds	10,642.00	
Wages of chargers and helpers	928.00	
Salaries of foremen	158.00	
Material handlers	528.00	
Wages of crane operators	233.00	
Fluxes, etc.	72.00	
Furnace repairs, including electrodes	2,372.00	
Laboratory expenses	312.00	
Maintenance of buildings	9.00	
Maintenance of cranes	70.00	
Depreciation—buildings	23.00	
Depreciation—equipment	169.00	
Insurance	6.00	
Taxes	40.00	
Power, heat and light	4,694.00	
General expenses:		
Salaries of superintendents and clerks; furnishings; office expenses; dining rooms; police officers; telephone and telegraph; prorated charges from general books, etc.	302.00	
One-third total defective castings 372		
Miscellaneous small tools 54		
(Remaining two-thirds against pouring floor)	426.00	
Portion of stores	10.00	
Total	$21,525.00	
Total output exclusive of melting loss		929,936 pounds
Average cost per pound of steel at spout	$0.0231	
Loss, heads, gates, splashings, etc.		324,726 pounds
At $0.0125 per pound	$4,059.00	
Net output		605,210 pounds
Cost per pound of steel in molds	$0.02886	

A power cost of ½ cent per pound, and an average cost per pound of steel at spout of 2.31 cents, or net cost in the molds of 2.886 cents per pound, is not what could be called a low cost; but it is unquestionably low for the conditions, and indicates a vigilance in management obviously directed toward overcoming the admitted short-comings of the installation. The particular immediate impediment to reducing cost is lack of pouring floor space. The furnace operation must be slowed down at present because the floor is unable to take its capacity. This situation will be relieved somewhat, and a lower melting cost should prevail when the addition to the foundry is in operation. This is now under construction. It will be equipped to make small green sand castings in amount sufficient to take one furnace heat per day.

Defects Are Evident

The results of operation have not been such as to prove the theory of design and mechanical features of the furnace to be the best obtainable. The two most serious defects seem to be that the roof does not last so well as does the circular roof, and that the electrode masts lack rigidity against side whip. The door construction is poor. For some unkoown reason, the furnace was designed with

(*Concluded on Page* 709)

Graphite Form in Gray Iron--II

Some of the Simpler Foundry Applications of Microscopic Study Based on Actual Problems Are Pointed Out—Effects of Operating Conditions Must Be Considered When Drawing Conclusions from Metallography

BY J. W. BOLTON

EXPERIENCED foundrymen care about metallurgy only insofar as it will help them to make better castings. Why all these analyses, micrographs, etc. if they do not produce visible results? Unfortunately, too much data is conceived of in an office instead of in the foundry. Why, for example, make exact tests on strength of cores when cold, when after being heated the cores lose most of their strength? Conditions in actual practice must be duplicated before experimental results can be considered really valuable.

Microscope Helps

Practical microscopic study of commercial gray irons has been undertaken only during the past 8 or 10 years and today not much use of such work is made by the average foundry. This is unfortunate, because the microscope generally helps give a clear idea of the real conditions existing in the metal. In this article the author points out some of the simpler foundry applications of microscopic study, based on actual problems met, and indicates the various changes in structure occurring during melting, etc. Needless to say, since conditions in different shops vary so greatly, foundrymen should not try to duplicate any results given without taking *all* factors into careful consideration.

In the manufacture of pig iron, the iron ore, coke, air and fluxes used give the following major reactions:

Coke burns with limited air supply, forming carbon monoxide.

Iron oxide of the ore interacts with the carbon monoxide to give iron and carbon dioxide.

The pasty, barely molten iron soaks up carbon from the coke, forming the more fusible pig iron.

Thus the coke is the original source of graphite carbon. This is somewhat analagous to melting steel scrap in the cupola. There the scrap absorbs carbon from the coke and becomes a sort of pig iron. It thus loses its identity and properties as steel.

Charcoal Iron Used

Years ago, cold-blast charcoal iron was used extensively. Today hot-blast coke iron is most common. Years ago, nearly all iron was sand cast. Today a large majority of merchant pig iron is machine cast. Much has been written concerning the relative merits of the various types of pig iron. Whether or not charcoal iron is the best, it is true that charcoal iron in quantity is commercially impossible today. The arguments for and against machine-cast iron are still with us. Without taking any sides, the author desires to explain the structural difference which exists in the two types.

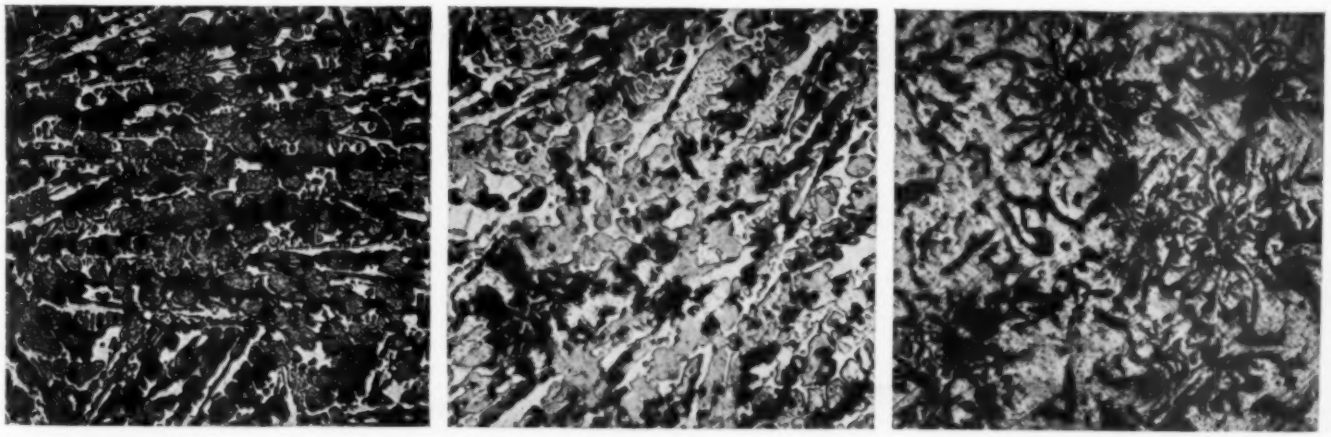
Take two pigs, one machine cast, one sand cast, both having the same analysis. The machine cast, Fig. 4, will show a closer grain, and possibly a chill around the outside. The sand-cast pig probably will show a darker and more coarsely crystalline fracture. Judging by frac-

Our Apology

IN THE first article of this series, published Aug. 15, a number of mechanical errors are noted, which unfortunately serve to mar the value of Mr. Bolton's discussion. The group of micrographs on page 658 was interchanged with that on page 661, while the captions are in the correct positions. Thus the micrograph shown as Fig. 1 should be over the caption Fig. 3, and the group noted as Fig. 3 should be over the caption Fig. 1. With this change made the figure numbers in the text should be corrected as follows:

No. Given	Correct No.	No. Given	Correct No.
1C	Fig. 1, A	9C	Fig. 1, I
2C	Fig. 1, B	10C	Fig. 1, J
3C	Fig. 1, C	11C	Fig. 1, K
4C	Fig. 1, D	2D	Fig. 3, B
5C	Fig. 1, E	3D	Fig. 3, C
6C	Fig. 1, F	4D	Fig. 3, D
7C	Fig. 1, G	6D	Fig. 3, F
8C	Fig. 1, H		

The sentence at the end of the second paragraph, page 664 should read: The available evidence indicates that these graphite groups came from existing or even pre-existent ledeburite.



Figs. 1, 2 and 3 illustrate the genesis of the whorl formations—They also indicate that primary graphite first comes from cementite-rich areas

Fig. 1 is from the edge of a mottled bar. Note the white dentrite of cementite and the black bunches of graphite occur together. This shows that the first graphite comes from the cementite. Section polished, etched, and lightly repolished. Magnified 75 dia. Fig. 2 shows further from the edge of the bar than Fig. 1. The primary graphite is beginning to coalesce in the whorls. Magnified 75 dia. Fig. 3 shows whorls of graphite flakes. Magnified 100 dia.

ture, the sand-cast iron should form the softer mixture. The microscope would probably show large graphite and much ferrite in the center of the sand-cast pig. The machine-cast pig might show cementite-rich areas on the outside, while the inside would have much pearlite and small graphite. Will the two irons on melting and pouring exhibit the same structural differences? No. Why? Well,

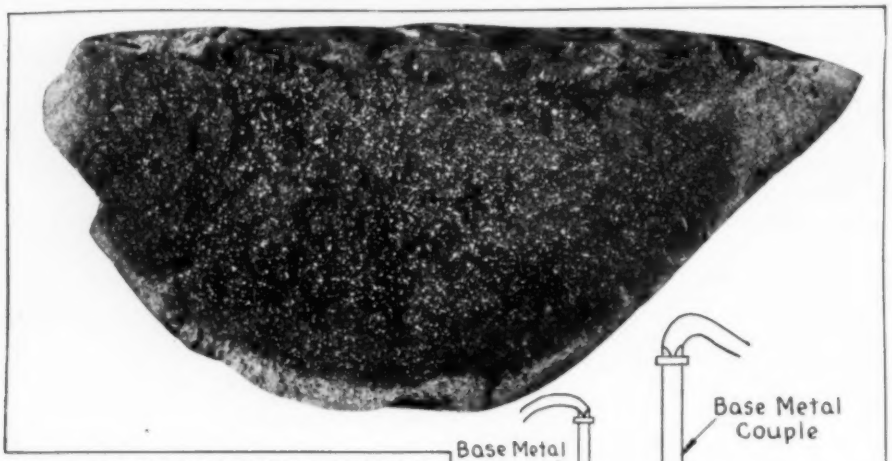
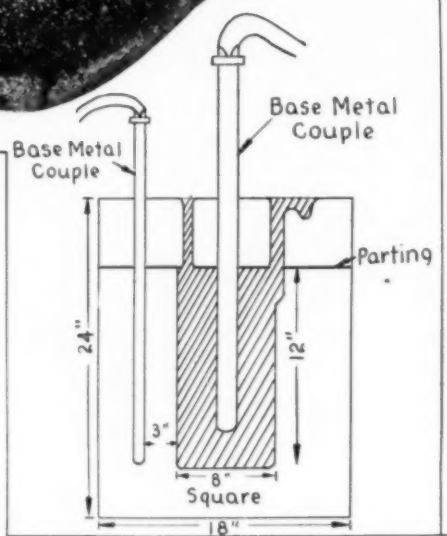


FIG. 4—ABOVE—FRACTURED SECTION OF MACHINE-CAST PIG—NOTE CHILLED EDGES

after charging the machine-cast pig it becomes hotter and hotter. Before it is completely melted, the pearlite has changed to austenite and the graphite is reabsorbed to form cementite. Somewhat the same change is gone through by the sand-cast pig. Just before the metal becomes completely molten, the ferrite has absorbed enough carbon to form austenite and the rest of the graphite has been reabsorbed to form cementite. Thus, when molten, the two irons are structurally similar. The fact that these changes have taken place just before complete melting explains why the spout temperature of machine-cast and sand-cast irons are not appreciably different. The above statements are not theories, but are based on actual experiments in the foundry and shops of the Niles Tool Works Co. There may be differences in various irons of the same apparent structure and analysis. These differences may be due to dissolved gas and similar slightly known phenomena. Such differences, while usually insignificant, sometimes effect remarkable changes in the properties of the metal. Concededly better pig iron, wrongly used, will not make as good a grade of casting as a poorer iron used intelligently. For example, we have in mind the experience of a foundry making some hard-iron rolls—not chilled. The job was a new one and a special iron was recommended. After considerable trouble and expense the iron was obtained and some rolls made. Numerous holes large enough to stick matches into were uncovered by the machining operation. Then by merely changing the composition to get 0.60 per cent silicon instead of 1.40 per cent, using none of the special pig iron, sound castings were secured. When finished, the last lot of rolls looked like mirrors. No one could, in fairness, blame the special iron for the original failure; for the mixture would have given good results in a casting of smaller section. Take another case. A foundry made only an occasional analysis. It got, unknowingly, a few cars of iron containing a little higher silicon than the pig iron which usually was received. Jobs like big cylinders were honeycombed with holes. Thoroughly scared the foundryman concluded the difficulty was caused by high sulphur. Mixtures containing 90 per cent pig iron were used but produced no better castings. Lower silicon was tried with some slight success. Finally the sulphur was raised. This, with the lower silicon has enabled that foundry to turn out many beautiful, close-grained castings. There are lots of such examples, too.

Approach Same Structure

Coming back to consideration of the melting process, we see that on passing down the cupola toward the melting zone, both machine and sand-cast irons approach the same structure just before and during melting. Of course, in this statement we are presuming good cupola practice, embodying small, evenly mixed charges, the right amount of air, etc. Scrap gray iron goes through much the same structural changes as pig iron. With steel scrap the story is somewhat different. The melting point of steel is much higher than that of gray iron. However, the hot, almost pasty, steel scrap absorbs carbon from the coke, and just before or during melting most of the steel becomes a sort of pig iron containing but small amounts of silicon and phosphorus. It is in the differences



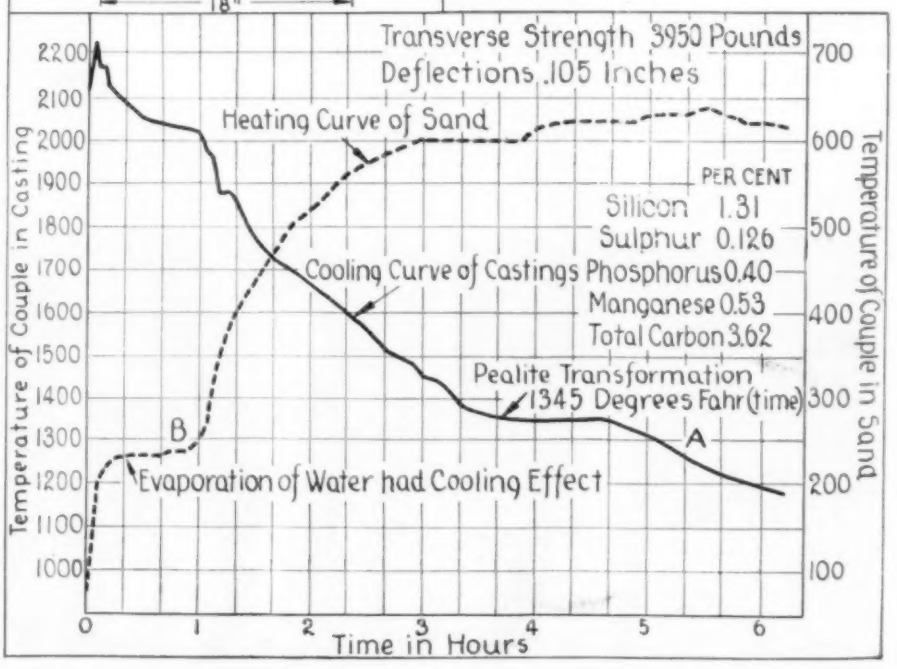


FIG. 5—AT CENTER—SET UP OF MOLD USED IN COOLING CURVE EXPERIMENTS
FIG. 6—BELOW—COOLING CURVE OF CASTING COMPARED WITH HEATING CURVE OF THE SAND OF THE MOLD, SHOWING THE PEARLITE TRANSFORMATION POINT—SPOUT TEMPERATURE 2575 DEGREES FAHR.—POURING, 2475 DEGREES

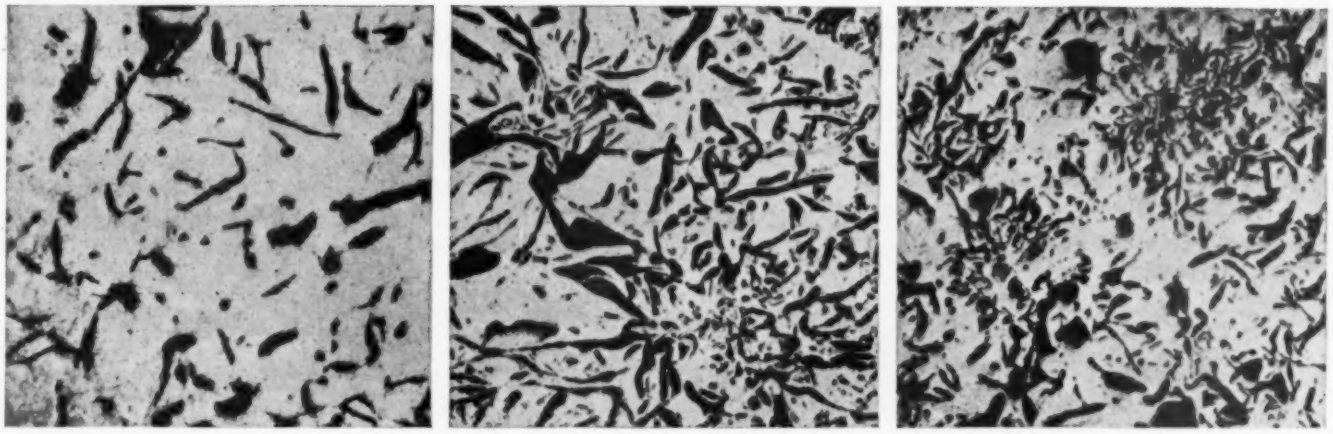


Fig. 7—Structure of center of a 2-inch bar which gave high results when broken in shock test—Note small and well distributed graphite flakes—Sample polished but not etched—x 100 dia. Figs. 8 and 9—Center and edge respectively of a transverse bar, 1½ inches in diameter—Note the coarse graphite in Fig. 8 and the heavy whorls in Fig. 9—Transverse strength 3100 pounds with 0.085-inch deflection—Total carbon 3.65 per cent—Unetched—x 75 dia.

existing between this *steel* pig iron and hot-blast coke pig iron that we must look for the remarkable differences between high-test irons and ordinary gray irons. Even after discounting for the differences in composition, the balance of proof leads to the belief that the steel exerts an effect *per se*. The same was true of the old cold-blast charcoal irons.

The author considers that there exists a remarkable analogy between the old cold-blast charcoal process and the melting of *steel* pig iron in the cupola. The hot-blast coke process is a high-temperature, strongly reducing process. The cold-blast charcoal process was operated at lower temperature and was less strongly reducing; indeed, the late J. E. Johnson Jr.'s oxygenating process for producing compact graphite flakes and, consequently, a strong iron, was conceived from the knowledge that the cold-blast irons were exceedingly strong. The cupola process making the *steel* pig iron is low temperature and certainly not strongly reducing. This analogy merits careful study by all foundrymen. While the presence, if not absorption, of oxygen, or possibly carbon dioxide, may have a favorable influence on the formation of *steel* pig iron, a large excess of oxygen is certainly harmful. The fact that the best and strongest irons are produced only when excessive air is not used, points to the possibility of influence of carbon dioxide. There is no particular contradiction here, as there must exist a proper balance for every element. For example, high sulphur is not so bad until excess air is used. It then seems that there is an interaction between the sulphur and oxygen to form a gas and blowholes result.

Know Little About Coke

We say that the iron and steel pick up carbon from the coke. There is the trouble. We all know that the coke has a lot to do with the carbon in the iron. The carbon in the pig came from the coke in the blast furnace. Carbon is absorbed, or, in some cases lowered in the cupola. The coke is the unmanageable factor as little is known about the influence of various cokes on carbon in iron. We do know that a higher bed will give higher total carbon, other factors equal. Also, some cokes seem to give up carbon more readily than others. Time, temperature, quantities of reacting substances (coke and iron) together with other factors such as humidity of air, condition of slags, etc., remain to be studied more closely under actual cupola conditions.

C. E. Williams and C. E. Sims* have published results obtained in carburizing synthetic cast irons in the electric furnace. They conclude that carburization up to 2.5 per cent carbon is rapid, no great differences in rates of solution of different carbon-rich materials being noted. Irons under 2.5 per cent carbon are rare in cupola practice. They found that different carbon-bearing materials carburized the iron at different rates. This is in accord with a theory we have held, that different coke structures will give different absorption. They

* THE FOUNDRY, May 15, 1922, page 390.

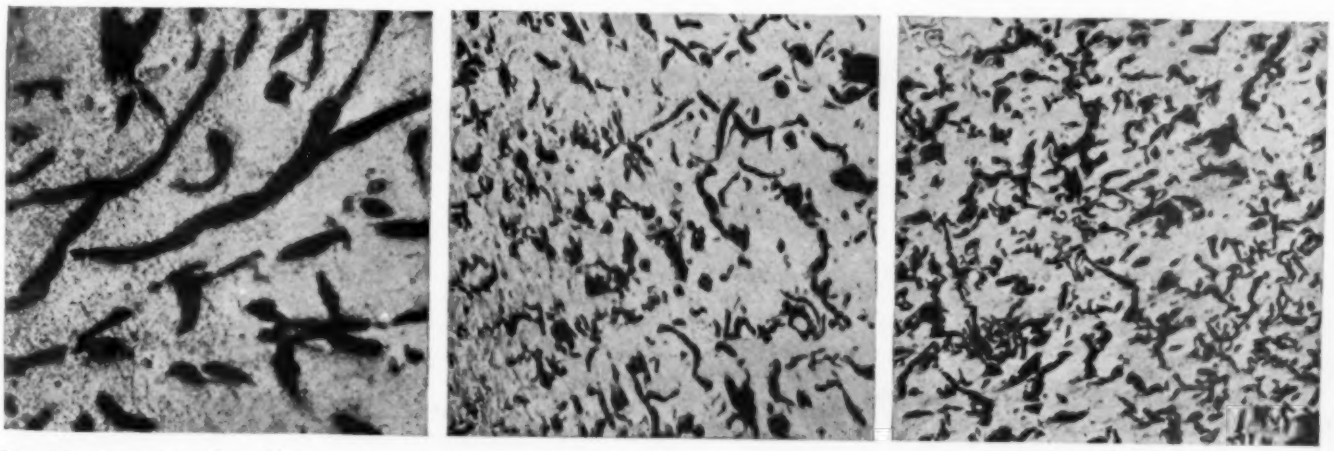


Fig. 10—Structure of a 4-inch section low in strength—Note coarse graphite flakes—unetched—x 100 dia. Fig. 11—Center of a 1¼-inch bar showing a transverse strength of 5100 pounds—silicon 1.07; sulphur 0.134; phosphorus 0.27; manganese 0.49; combined carbon 0.80; total carbon 3.28 per cent—Note small evenly distributed graphite flakes—Unetched—x 75 dia. Fig. 12—Structure near edge of bar illustrated in Fig. 11—Unetched—x 75 dia.

showed that high-ash coke gives up carbon less readily than low-ash coke. This checks with our own experiences under actual cupola conditions. The writers also claim that the general effect of slags (in electric furnace practice) is to retard absorption of carbon, except in special cases. This article, prepared under the auspices of the U. S. bureau of mines, merits study by every one interested in gray iron melting.

Gives Lower Carbon

Among experiences here it has been noted above that high-ash coke may give lower total carbon, and that a high bed promotes absorption of carbon. In this latter connection we noted one case where, over a period of some months, a faster melting coke and more frequent tapping out reduced the average total carbon some 0.25 per cent. In this case we were enabled to use about 0.15 per cent higher silicon in the test bars and still get the same strength. It seems probable that much of the carbon absorption occurs when the molten, and in some cases still pasty, metal trickles down through the bed.

It would be interesting to determine the differences in carbon effected by the use of a forehearth; i.e., practically no bed. The effect of melting temperature on carbon absorption also merits consideration. We have seen a number of instances where carbon absorption seemed promoted by slag. This might be due to the slag preventing much oxidation of the carbon in the iron. This was the case in some of our experiments in an oil-fired furnace. On the other hand, the slag might cover and partly help slightly to fuse the pores of the bed coke thereby preventing absorption. This latter theory is not well borne out by the condition of the coke in the drop.

So much has been written about proper and improper combustion in the cupola that the writer does not think it worth while to review it. We have, in certain cases, been able to get good results with 24,000 cubic feet of air per ton of iron melted. We have never seen a case where the use of over 30,000 cubic feet per ton of iron melted, produced much increase in the melting rate. On the other hand, there is little question but that excess air produces blowholes, the iron looking hot when running from the cupola, but losing life quickly. The amount of moisture in the air may be worth considering in tests on cupola melting.

Coming back again to our subject; we have the iron melted and ready to tap. At this plant tapping and pouring temperatures are taken frequently. An optical pyrometer has proved most satisfactory for this work, although many readings have been taken with thermocouple pyrometers. When tapped, a hot iron will run 2600 degrees Fahr. or above. Under 2500 degrees Fahr. the iron appears a little dull. Foundrymen have noticed the little silvery sheen which often covers part of the stream. We take our readings on the redder metal which shows underneath this sheen. It is difficult, if not impossible, to gage the temperature closely by looking at the stream. Certain things, such as the amounts of various elements, oxidation, etc., give the metal an appearance of fluidity which may prove deceptive.

The pouring temperature varies with the length of time the iron stands in the ladle. In our work the pouring temperatures run from 2300 to 2500 degrees Fahr. Heat loss in a large ladle covered with charcoal is slow, running around 200 degrees Fahr. per hour in a 9-ton ladle. For ordinary small ladles, handled quickly, the loss amounts to 100 degrees Fahr., or less.

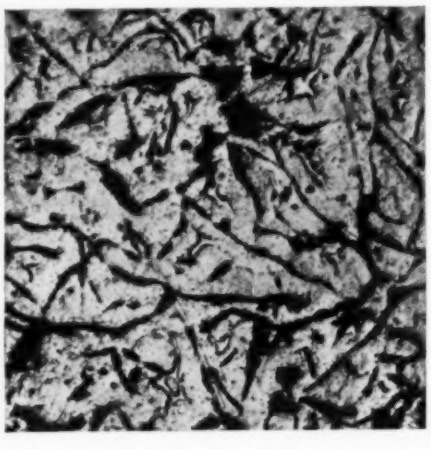


Fig. 13—Center of a bar showing only 2700 pounds transverse strength—Note long graphite flakes—Unetched—x 100 dia.

The quality of the finished iron is determined largely by what happens after the metal has been poured into the mold. Scabs, washes, dirt, etc., of course, are not due to the metal. The cooling rate is highly important and is not easily controlled. When first poured the metal is liquid, with some small particles of slag rising to the surface. After cooling somewhat and before any noticeable solidification, a remarkable phenomenon is seen in hypoeutectic irons. The surface of the metal suddenly presents a flowery appearance, large flakes resembling graphite appearing, then vanishing, their place being taken by more flakes. This action continues until the surface of the metal is completely frozen over. After considerable study, the writer has come to the conclusion that these flakes are due to graphitization of prima austenite just before final solidification of the metal. Thus we see that the first appearance of the weakening graphite flakes is just before final solidification of the metal.

These flakes may serve as nuclei for growth of graphite, separating later. In event of slow cooling, it would seem as though it were possible for these first flakes to grow large. What happens after final solidification is decomposition of the cementite (and austenite) to give graphite. At about 1345 degrees Fahr. the remaining austenite changes into pearlite. The separation of primary graphite is followed by graphite growth (formation of secondary graphite), as explained by the writer in previous papers. A typical cooling curve of gray iron as cast, is seen in Fig. 6. The arrangement of equipment used in determining the cooling curve is shown in Fig. 5. In the experiments of which that diagramed in Fig. 6 is representative, temperatures of both iron and sand were taken, as well as the room temperatures. In the particular curve given the platinum—platinum rhodium thermocouple did not get up to high enough temperature before solidification of the metal. This relatively small casting took 4½ hours to pass below the pearlitic transformation range, at *A*. The effect of water, shown at *B*, and the heat insulating properties of the sand are well illustrated in the heating curve of the sand.

The amount and kind of graphitization is affected by the cooling rate, which for practical purposes is synonomous with section size, by the amounts of the various elements in the iron, by the pressure, and by other factors. In examining hundreds of test bars, 1¼ inches in diameter, the writer has found that the most significant differences in low-strength bars (3000 pounds transverse and under) and high-test bars (over 4500 pounds transverse strength) is generally in the size and arrangement of graphite flakes. It is true there are other differences. For example, the combined carbon is often higher in the stronger bars, but 0.15 or 0.20 per cent difference in combined carbon could not make 50 per cent difference in strength. Insofar as we can find out, the only appreciable effects exerted by silicon are due to its action on the carbons. The phosphorus, sulphur and manganese do not seem to make any vast differences in the strength. Phosphorus reduces deflection, and in case of heavy castings sulphur may close the grain.

Described in First Installment

The interesting effect of total carbon content is described in the first installment of this article; namely that although lower total carbon may produce highest strength, at a certain higher carbon content, corresponding to the eutectic, the strength rises. This is prob-

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

ANALYSIS OF CUPOLA SLAGS

(*Continued from Data Sheet No.* 490)

Evaporate the remainder of filtrate to about 50 c.c. volume. Add about 200 c.c. water and 2 to 2½ grams ammonium chloride. Add ammonia in considerable excess and heat for 15 to 20 minutes, keeping moderate excess of ammonia. Filter through a coarse texture quantitave paper, washing well with hot water. Ignite precipitate and weigh Fe_2O_3. Weight Fe_2O_3 x 225=per cent FeO—the form in which iron oxide probably occurs in slag.

Boil off most of the excess ammonia. Determine lime and magnesia as under limestone (see Data Sheet No. 487) with the exception that the per cent MnO x 0.004 is subtracted from the weight of CaO. This is because a 0.4-gram sample is used for CaO and MgO rather than a 1.0-gram sample as in limestone.

Sulphur—Mix 1-gram sample slag, ground to 80 mesh, with 4 to 6 grams sodium peroxide, Na_2O_2, in iron or nickel crucible, and fuse about 30 minutes. Dissolve fusion in water, removing the last adhering particles with dilute HCl. Add conc. HCl until solution is clear, then evaporate to dryness. Add 10 to 15 c.c. conc. HCl and about 150 c.c. water, boil and filter off SiO_2. Heat filtrate to boiling and add 35 c.c. 10 per cent $BaCl_2$ solution, slowly and with stirring. Allow to stand at least 4 hours and filter on close ashless filter paper, washing thoroughly with hot water and dilute HCl. Ignite in porcelain crucible. Weight $BaSO_4$ x 13.7=per cent S. Blank ran on the Na_2O_2 should be subtracted.

Notes and Precautions—Re-evaporation of filtrate from first evaporation is necessary to determine the last small amounts of silica, which will otherwise be found contaminating the alumina. For accurate work it is always best to volatilize the silica with hydrofluoric acid.

The NaOH and KOH always contain impurities, and for accurate work these must be taken into account. In addition any excess boiling of the alkaline solution will dissolve silica from the glass. The exact determination of alumina

(*Continued on Data Sheet No.* 492)

ANALYSIS OF CUPOLA SLAGS

(*Continued from Data Sheet No.* 491)

requires careful work, including double precipitation of the other constituents, purification of the aluminum hydroxide, etc.

The bismuthate method for manganese is accurate, providing the last traces of chlorides have been removed. The lead peroxide method is satisfactory. The persulphate method has not been tried by the writer.

Where the volume of work is large the iron and aluminum might be precipitated with ammonia, in presence of considerable ammonium chloride; the iron determined by permanganate titration, and the alumina by difference from the sum of the oxides.

The ammonium chloride separation is not strictly accurate in presence of large amounts of manganese. Any difference on the amount of iron oxide is small and the manganese oxide is determined accurately in another portion.

The correction for manganese oxide in the lime is intended as an approximation sufficiently accurate for all practical purposes.

The practice of determining the lime and magnesia by difference is not recommended.

No contaminating silica has been found in any of the barium sulphate precipitate. The method given shows close duplicates and with ordinary precautions is quite accurate.

In taking the sum of the constituents determined it must be remembered that iron is present as metallic gray iron, as FeO, and possibly as Fe_2O_3. Some of the other constituents also occur in two or more forms. Such elements as titanium, and phosphoric acid which occur in small amounts have not been determined. Therefore the sum of constituents determined is not necessarily 100 per cent. This sum will generally be around 99 per cent.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

VOLNEY FOSTER
PRESIDENT

H. F. GOEBEL
SECRETARY

SAND FLINT SHOT BLAST

UNITED STATES SILICA COMPANY
122 SOUTH MICHIGAN AVENUE
CHICAGO
TELEPHONE HARRISON 2234

May 25, 1923.

THE FOUNDRY,
Cleveland, Ohio.

Dear Sirs:

Replying to your letter of May 23rd, we are very glad indeed to express our unqualified satisfaction with the results obtained from our advertising in THE FOUNDRY.

The use of FLINT SHOT is widely distributed throughout the United States and Canada and we are making regular shipments to both the Atlantic and Pacific coast. It would be impractical for our own salesmen to cover this large territory and consequently the majority of our sales are made through foundry supply houses.

Due to our effective publicity and the merit of our product, FLINT SHOT is sold by the best class of brokers.

We started using THE FOUNDRY when FLINT SHOT was first introduced in April 1916, and our advertising has appeared in every issue of your publication since that date.

Very truly yours,

UNITED STATES SILICA COMPANY,

Volney Foster

President.

VF*LJ

ably because the better distribution of graphite at the eutectic offsets in part the effect of more graphite.

When we leave test bars and consider the actual castings, we are confronted by vastly different conditions. Test bars are made under similar cooling conditions. Since cooling rate, or section size, is an important factor in getting the strength, the tendency is for less variation in strength and finish of test bars than is shown in castings with varying sectional thicknesses. There must exist a vast difference in cooling rates between sections ¼ inch thick and those 8 or 10 inches thick. When the castings are not nearly uniform throughout, of course, theoretically it is not possible to get the right mixture. Differences in the test bars are multiplied, or even reversed, when the irons are in the casting. Take, for example, two irons, one having 1.30 per cent silicon and 4500 pounds transverse strength, another with 2.25 per cent silicon and 3000 pounds transverse strength with other factors about equal. Suppose that the first bar is cast into a solid cylinder, 18 inches in diameter, while the other bar is made into a ¾-inch square bar. If we cut a transverse bar out of the center of the heavy casting, we will probably find it has only about 2000 to 2500 pounds transverse strength. If we break the smaller bar and convert its test to the round bar, we will possibly find that it figures over 3000 pounds transverse strength. Actual experience or experiment is necessary to get the best mixture for any grade of casting. The metallurgist, because of his more general experience and close study, is often able to predict the right mixture for any given casting.

Get Mixture from Cupola

Once the best mixture for a class of casting is found, the next problem is to get the mixture from the cupola. In case of production foundries, working on the same type of casting for months, the problem is not hard. With ordinary care the mixture will not show any appreciable variations from day to day. If the same grades of iron and coke are used continuously the variations will be negligible, and the castings will be of uniform physical properties. If more than one mixture is used it will be found that there will be considerable overlapping between mixtures. This is because the differences in size and in some cases differences of melting points in the materials charged allows the charges to become mixed during melting.

Of course, careless charging will produce bad results. It is not possible to get four or five different mixtures out of a small heat, or to sandwich a small amount of some special mixture between large amounts of regular mixtures. The practice of using heavy coke charges between mixtures is open to criticism in that it simply raises the bed. We have found in our own work, making three mixtures, that it is possible to keep within reasonable analytical limits almost 100 per cent of the time. Any slight overlapping causes no trouble as the large ladles insure mixing. The important thing to remember is to adjust the silicon content to *both section size* and *total carbon*. Excess carbon promotes graphitization as does silicon. Therefore, if the iron is high in carbon, lower silicon must be used than would be necessary with a high-carbon iron.

Can Regulate Finish

Where quality castings are made there must be close watch kept of the castings when in the machine shop. As stated before, the test bars are only indicators, the finished casting being the deciding factor. The buyer, the machine shop man, and often the foundryman, judge the quality of the iron in the casting by its appearance on machined surfaces. This practice has led to great injustices to the foundryman and the buyer. It is true that the quality of the metal is indicated largely by its grain, if by grain we mean size of graphite flakes. But no one except one trained in the metallography of gray iron can *always* tell the grain by looking at a finished surface. The fracture cannot be examined on a big machined casting. The finish of a machined surface can fool the most expert. Take two castings, one a fine grain, high-class iron, the other a mere sponge. Grind both of them. Both, if ground in certain ways, present a perfectly smooth, shiny surface. This is because the peening or hammering action of grinding drags a surface film of metal over the porous spots. *The very worst looking open-grain iron can be made to look better than the best high-test iron merely by different finishings.* The foundryman making quality castings must be on the alert to defend his product against inferior products finished to look better. The microscope is an invaluable aid, for after careful polishing, which does not drag any metal, the microscope shows the true grain size. An infinite variety of finishes are possible. The worst from the appearance viewpoint, but the most honest, is produced by a heavy roughing cut followed by a light finishing cut and light scraping. Grinding gives the best appearance but can be used to cover up open metal. The fact that a piece is ground should not condemn it, as many manufacturers grind their finest metals. Light roughing and finishing cuts make a close grain appearance. Heavy scraping or filing also makes the metal look better. The point is to make a real good high-test iron which will not tear out badly under heavy cuts and to see that this iron is not compared with a poor grade of metal nicely finished. It must be remembered, too, that the more stock that is taken off, the more open the metal will look. Today metal cutting is done with high-speed steel and stellite. In the olden days carbon tool steels were used. In many cases the better appearance of the older metals is due to the better appearing finish given in the days when labor was cheap and machine tools could not take heavy cuts.

Thus we have shown a number of points in regard to the structure of gray iron. Pig irons of the same analysis assume similar structures during and after melting. The formation of *steel* pig iron in the cupola bears some resemblance to the formation of pig iron in the cold-blast charcoal practice. The hot-blast coke process, strongly reducing, produces weaker iron than the cold-blast and cupola *steel* pig iron processes which are not so strongly reducing and proceed at lower temperatures. This may explain the difference in strength between high-test and cold-blast irons on one hand and hot-blast coke irons on the other. The coke used governs the absorption of carbon in the cupola. Melting, pouring and cooling temperatures should be determined. Attention to details and study of the castings together with analyses and physical tests are necessary for producing the best grade metals. Finish of metals may cause wide variations in appearance. The best grade of metal will present a reasonably good appearance no matter what finish it has had, but a poor metal can be disguised by careful finishing.

British Begin Research

Research conducted by the British Cast Iron Research association is making progress, according to the monthly report of its secretary, Thomas Vickers, who states that experimental castings are continually being made in various foundries to obtain data on chemical and physical properties. Important results on draws and shrinkages are being obtained. Arrangements are being made for a thorough investigation of foundry sands to be carried out at Birmingham university. Engine cylinders have been cast to variable specifications and are being tested. The joint research with the Glass Research association on glass molds is making progress. Steps have been taken looking toward standard specifications for gray iron castings in conjunction with the British Engineering Standards association.

Steel Foundry Reflects Growth

Experience of Executives Gained Over a Period of Many Years Is Crystallized in Building, Plant Layout and Equipment Installed in New Electrical Steel Foundry in West Virginia

BY JOHN D. KNOX

GEOGRAPHICAL location in its important bearing on the economical operation of a plant was the predominating incentive in influencing the Blackwood Electric Steel Corp., to establish an electric steel foundry in Parkersburg, W. Va. Natural resources in this section of the country are responsible for low fuel and power costs and in addition an ample supply of sand and clay suitable for steel foundry purposes are found in the immediate vicinity. Attractive shipping facilities are afforded on the river and also by steam and electric railroad. The plant is located in a position where it can ship directly over the main line of the New York-St. Louis and the Ohio river division of the Baltimore & Ohio railroad; Chesapeake & Ohio; Pennsylvania; Erie; and New York Central systems.

The plant has been erected in the new industrial section of the city where the corporation owns a 16-acre property with natural topographical features to insure an ideal dumping ground for waste material over a period of many years. The first heat was poured on June 23, 1923, or in a little over six months after construction started in December, 1922. The main building lying north and south covers approximately 32,000 square feet of floor space. It is constructed of brick and structural steel and is amply lighted through windows set in steel sash that forms the greater part of the end and side walls and also the roof over the two side bays. Vertical sash in the sides of the monitor roof may be opened or closed in sections by suitable devices controlled from the floor and furnish all the ventilation required. The main bay is surmounted by a V-shaped tile covered roof designed to collect rain water. Three pipes lead from the central roof gutter and conduct the rain water to a concrete reservoir outside one end of the building where it unites with water from the city mains. This means of softening the water was adopted when it was discovered that the city water constantly is impregnated with chlorine. The water is pumped from the reservoir into a storage tank and then distributed through suitable piping for use throughout the foundry. Steel water barrels are placed at the base of several building columns for the convenience of the employes and the overflow water is conducted back to the reservoir.

The layout of the foundry shown in Fig. 9 provides ample room for the several operations involved in the production of castings. In addition it will be noted that the flow of material and the sequence of operation tends steadily in one direction toward the shipping room. Steel for the wide variety of castings is melted in a 1½-ton electric furnace set up at the west side and near the south end of the main bay. The heavy castings are made in this center bay partly shown in Fig. 2. The molds are rammed at two stations each equipped with two jolt machines. One station is close to the south end of the building and the other is located about half way along the west side of the main bay. Attention is directed to Fig. 9 where the position of the molding stations is indicated.

Air for operating the jolters, sand blast equipment and for miscellaneous use throughout the foundry is supplied by a 2-stage motor-driven compressor with a piston displacement of 600 cubic

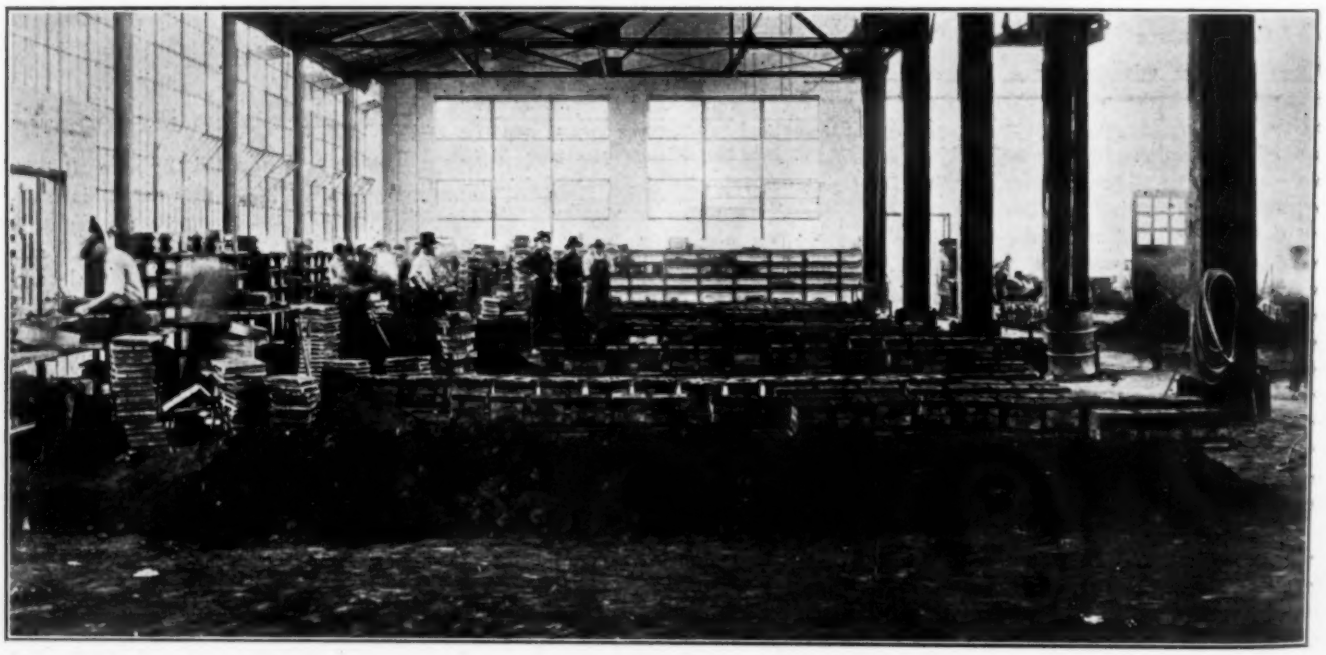


FIG. 1—LIGHT MOLDING FLOOR OF THE BLACKWOOD ELECTRIC STEEL CORP.'S NEW FOUNDRY, PARKERSBURG, W. VA. PATTERNS ARE STORED ON STEEL RACKS INSTALLED ALONG THE END AND SIDE WALLS

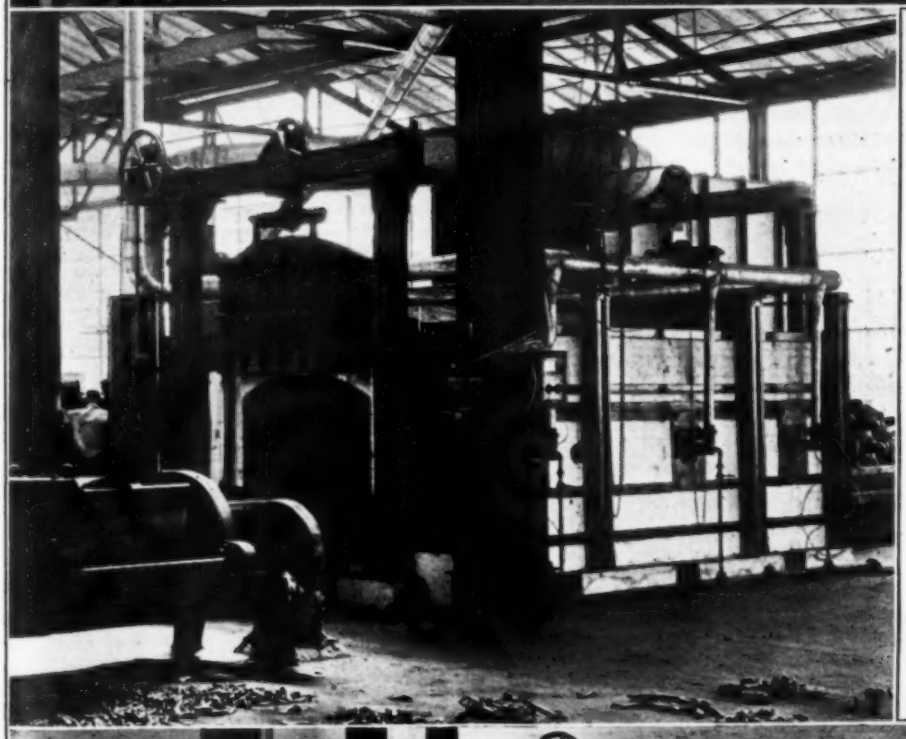
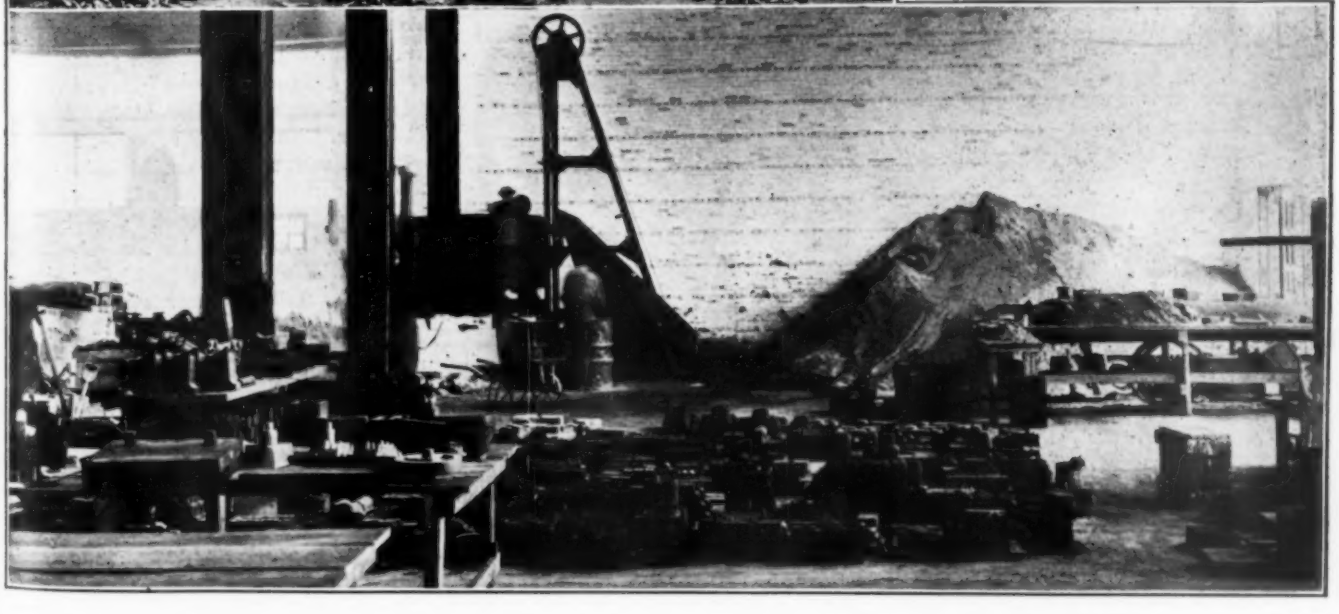


Fig. 2 (Above) Main bay showing heavy pouring floor and electric furnace in the right background.

Fig. 3 (Left) Sand blast system is shown in the rear of the tumbling barrels and the annealing furnace is shown to the right.

Fig. 4 (Below) Coremaking and sand mixing departments are housed in the western leanto.



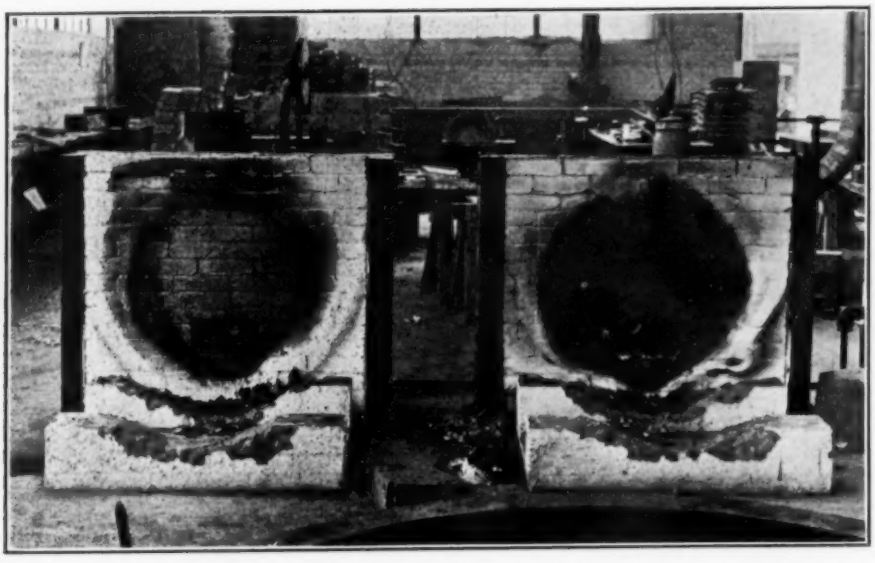


FIG. 5—LARGE BULL LADLES WITH THEIR RIMS COINCIDING WITH A REFRACTORY WALL ARE HEATED BY NATURAL GAS. TWO HEATING FURNACES ARE SHOWN IN THE FOREGROUND

feet. An automatic cut-out is provided for a working pressure of 80 pounds per square inch. A leanto parallels the main bay along the western side and houses the pattern and carpenter shops, chemical laboratory, transformer room, power house, and the sand mixing, coremaking, cleaning and annealing departments.

While the pattern and carpenter shop at present occupies a corner section of the foundry, as shown in the background of Fig. 5, plans call for the removal of this department to a separate building. The shop is equipped with a direct motor-driven swing and band saw, a planer and a sander. A chemical laboratory is operated in conjunction with the foundry and is housed between the pattern shop and coremaking department. Preliminary and final analyses are made of all heats and the steel is held in the furnace until it conforms to the desired chemical specifications.

Sand Mixed Mechanically

Facing and core sand are prepared in the western bay by a muller-type sand mixer equipped with a 6-foot diameter pan. The mixer is shown at the rear of the core room in Fig. 4. Located in the center of the pan is a vertical shaft to which a central supporting cross head is keyed. The crosshead rests on a turret in which bearings for the central shaft are mounted. This shaft is operated by bevel gearing located below the machine. The central supporting casting carries two outside plows, one inside plow and two mullers. The purpose of the plows is to turn over and move the sand mixture alternately inward and outward. The outside plows move the sand toward the center and the inside plow toward the rim of the pan, while the mullers revolve on their own axes around the center of the pan, their pathway being at a point where the mixture is heaped up the highest by the movement of the plows. The action of the plows, together with the kneading and squeezing action of the mullers result in a thorough incorporation of all the elements of the mixture.

Loading the sand into the mill is accomplished by a bucket which is elevated to a point where the material falls into the pan by means of a clutch operated winch, driven from the driving shaft of the mixer. The bucket then returns to its loading position against a brake. To discharge a batch of sand a door located in the bottom of the pan is opened by pulling a lever on the side of the mill. The plows that turn the mixture over upon itself and under the mullers discharge the contents automatically into a chute which in turn discharges into a box, wheelbarrow or other container. The loader increases the capacity of the mixer by having a charge ready to be fed into it as soon as the previous batch has been discharged; it maintains an accurate and uniform feed into the mixer because the bucket holds the correct quantity of sand for one batch; and it assures feeding all the sand into the mixer at once.

Dust Arrester Is Provided

The core room, situated in the western bay near the sand mixing department, is equipped with an eight compartment oven fired with natural gas All cores are handled on steel plates as shown in Fig. 4. Nearby is the cleaning room in which is installed a hygienic sand blast cabinet, a barrel-type sand blast and two 24 x 48-inch tumbling mills, all ventilated from a single dust arrester exhaust system. The sand blast cabinet has a rotative table, 5 feet diameter, built at floor level and is equipped with a partition, 12 inches high, thus permitting the handling of the largest castings produced. One half of the table is enclosed by a semicircular cabinet which gives a tight blasting compartment; the other half is exposed.

In the housing of the cabinet is a nozzle slot extending its entire length and closed by sectional rubber curtains through which the operator, working on the outside, directs the sand blast nozzle. This is accomplished by means of a pole fitted with flexible connections that permit reaching all exposed surfaces of the work. The hose machine is of the direct pressure type. Sight hoods

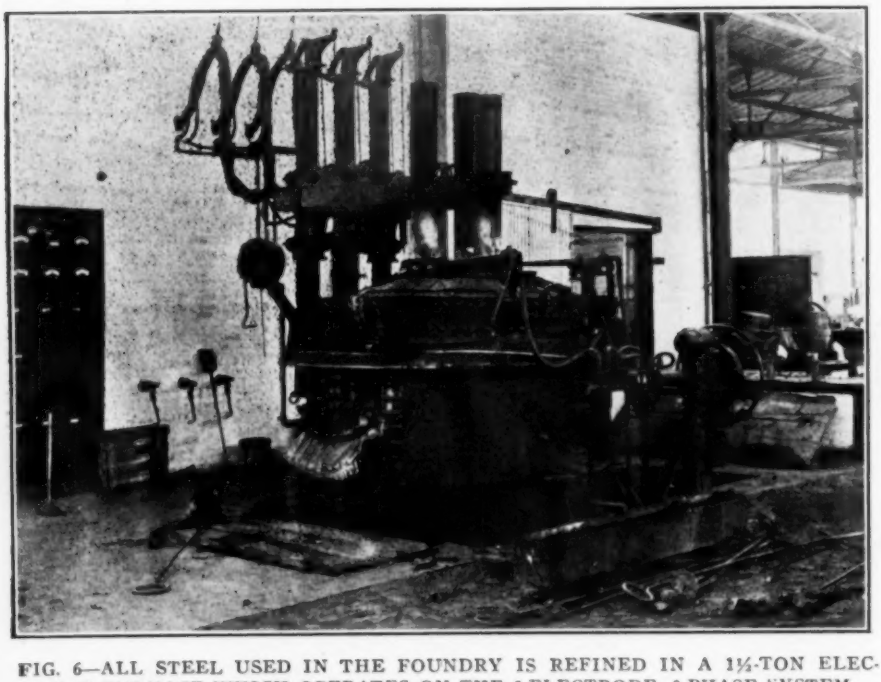


FIG. 6—ALL STEEL USED IN THE FOUNDRY IS REFINED IN A 1¼-TON ELECTRIC FURNACE WHICH OPERATES ON THE 3-ELECTRODE, 3-PHASE SYSTEM

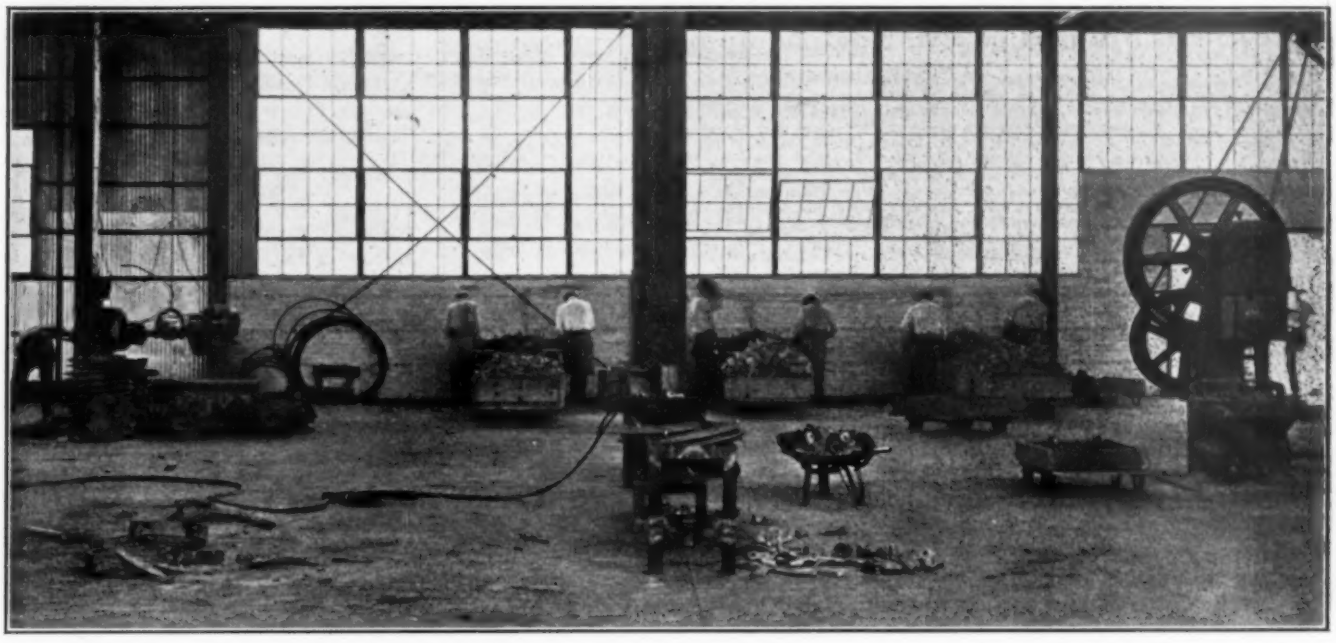


FIG. 7—SPRUES TOO HEAVY TO BE REMOVED FROM THE CASTINGS BY THE MOTOR-DRIVEN SPRUE CUTTER SHOWN AT THE RIGHT ARE CUT BY AN OXYACETYLENE TORCH ON THE BENCH SHOWN IN THE FOREGROUND THE GRINDING DEPARTMENT SHOWN IN THE REAR IS EQUIPPED WITH STAND AND SWING GRINDERS

with wire inserted glass are installed in the top of the equipment and through these the operator views the work from all points of the cabinet, the interior being thoroughly illuminated by electric light fixtures provided with white enameled reflectors.

The work is loaded or unloaded on the exposed part of the table while the blasting operation is being performed in the closed half of the cabinet so that it is only necessary to rotate the table a half turn to bring new work to the operator. The cabinet has down-draft ventilation through the grating of the table floor, the dust laden air being exhausted as rapidly as created, thus affording a clear vision on the interior of the cabinet constantly. The spent abrasive, core, molding sand, etc., pass to a hopper beneath the cabinet where a screw conveyor transfers the material to an elevator boot which in turn raises it to a separator. By mechanical vibration and an exhaust system the usable abrasive material is reclaimed and passes to storage bins which serve the sand blast machine. The coarse and fine refuse is accumulated in a bin where it is removed as required.

The barrel sand blast is of the direct gravity sight-feed type having two nozzles, one on either end of the 30 x 40-inch drum. The heavy cast heads are

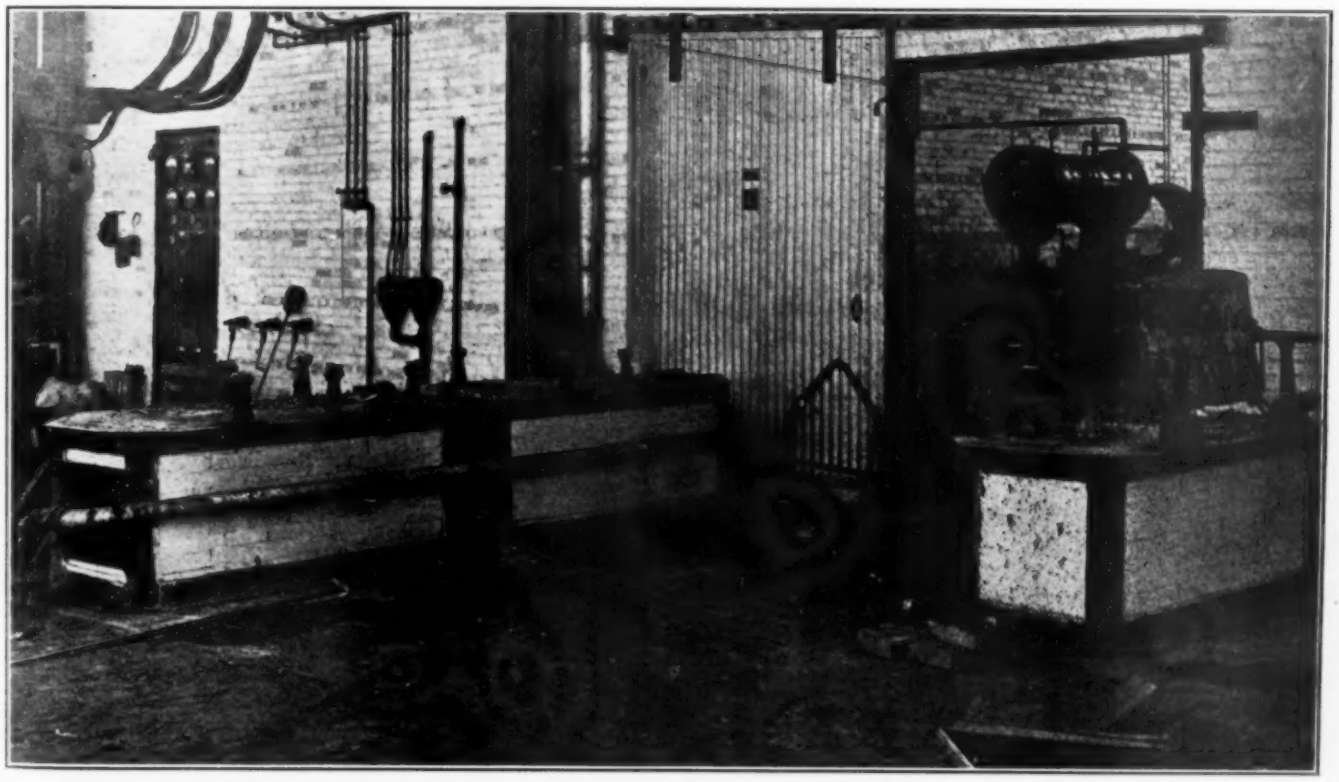


FIG. 8—ALL HAND-SHANKED LADLES USED IN THE FOUNDRY ARE KEPT WARM BETWEEN HEATS BY GAS-FIRED, RECTANGULAR-SHAPED OVENS IN THE TOP OF THE ROOF ARE HOLES THROUGH WHICH THE FLAME IS EJECTED INTO THE LADLES WHICH ARE IN AN INVERTED POSITION ON STANDARDS

Makers of Principal Equipment

Air compressor Pennsylvania Pneumatic Co., Erie, Pa.
Annealing furnace F. J. Ryan & Co., Philadelphia
Blower motor Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Buildings Massillon Bridge & Structural Co., Massillon, O.
Bull ladles, 3-ton Whiting Corp., Harvey, Ill.
Crane, 7½ ton Milwaukee Electric Crane & Mfg. Co., Milwaukee
Core oven F. J. Ryan & Co., Philadelphia
Core plates The Wadsworth Core Machine & Equipment Co., Akron, Ohio.
Electric furnace, 1½ ton Pittsburgh Electric Furnace Corp., Pittsburgh
Electric furnace transformer Pittsburgh Transformer Co., Pittsburgh
Electric welding equipment Lincoln Electric Co., Cleveland
Fire door Merchant & Evans Co., Philadelphia
Jolters Herman Pneumatic Machine Co., Pittsburgh
Platform scales Howe Scale Co., Rutland, Vt.
Pressure blower Buffalo Forge Co., Buffalo
Pyrometer Brown Instrument Co., Philadelphia
Sand blast system Pangborn Corp., Hagerstown, Md.
Sand mixer National Engineering Co., Chicago
Sprue cutting machine J. C. Busch Co., Milwaukee
Squeezers Arcade Mfg. Co., Freeport, Ill.
Stationary grinders United States Electrical Tool Co., Cincinnati
Steel sash David Lupton's Sons Co., Philadelphia
Swing grinder Safety Emery Wheel Co., Springfield, O.
Synchronous motor, air compressor Fairbanks, Morse & Co., Chicago

steel tired and rotate on manganese steel rollers fitted with roller bearings. Only the rear rollers are driven. Small rollers fitted with ball bearings are provided at the periphery of the drum to take care of occasional side thrusts. The barrel is driven by a chain belt and gears which operate in a dust-tight oil bath. A single exhaust system passes the dust laden air from the entire cleaning room equipment through a cloth screen dust arrester built with hoppers beneath to provide for convenient unloading. The screens are kept free of accumulated dust by power-driven vibrators.

A leanto given over to the molding of small castings parallels the main bay along the eastern side, as shown in Fig. 1. Six small air-operated jolters are arranged along one side of this bay 10 feet apart. A cement walk, 5 feet wide, is laid between the jolters and the side wall while a similarly constructed walk runs along the southern end of this leanto. Tiers of steel shelving are arranged along the side and end walls of the small casting department and upon these are stored the various small patterns, properly tagged. The rear end of the bay devoted to the molding of small castings is occupied by the grinding department. Here are installed three stand grinders, as shown in Fig. 7. Nearby are two cutting stations where gates too large to be severed by the sprue cutting machine are cut by oxyacetylene torches, the acetylene being generated in a station outside the main building.

Large Leanto Houses Grinders

Across the rear of the building is a 30 x 139-foot leanto walled and roofed with galvanized sheets inset with steel sash. In case of expansion this leanto can be moved toward the rear of the property to make room for the extension of the main building. The leanto houses three motor-driven swing grinders and the chipping, acetylene and electric welding, inspection and shipping departments.

Materials used in connection with the operation of the foundry, including fire clay, mica schist, electrodes, steel grit, ferromanganese, ferrosilicon, furnace brick, etc., are brought into the plant by electric railway and unloaded through doors in the side of the storage building situated near the western side of the foundry structure. Scrap is piled near this building and in close proximity to a cement runway leading to the electric furnace. Molding sand also is unloaded along the western side of the main building opposite a door through which it is transferred to the sand mill, shown in Fig. 4.

Power for plant operation is purchased at 2200 volts from the West Penn Public Service Co. and is stepped down to 110

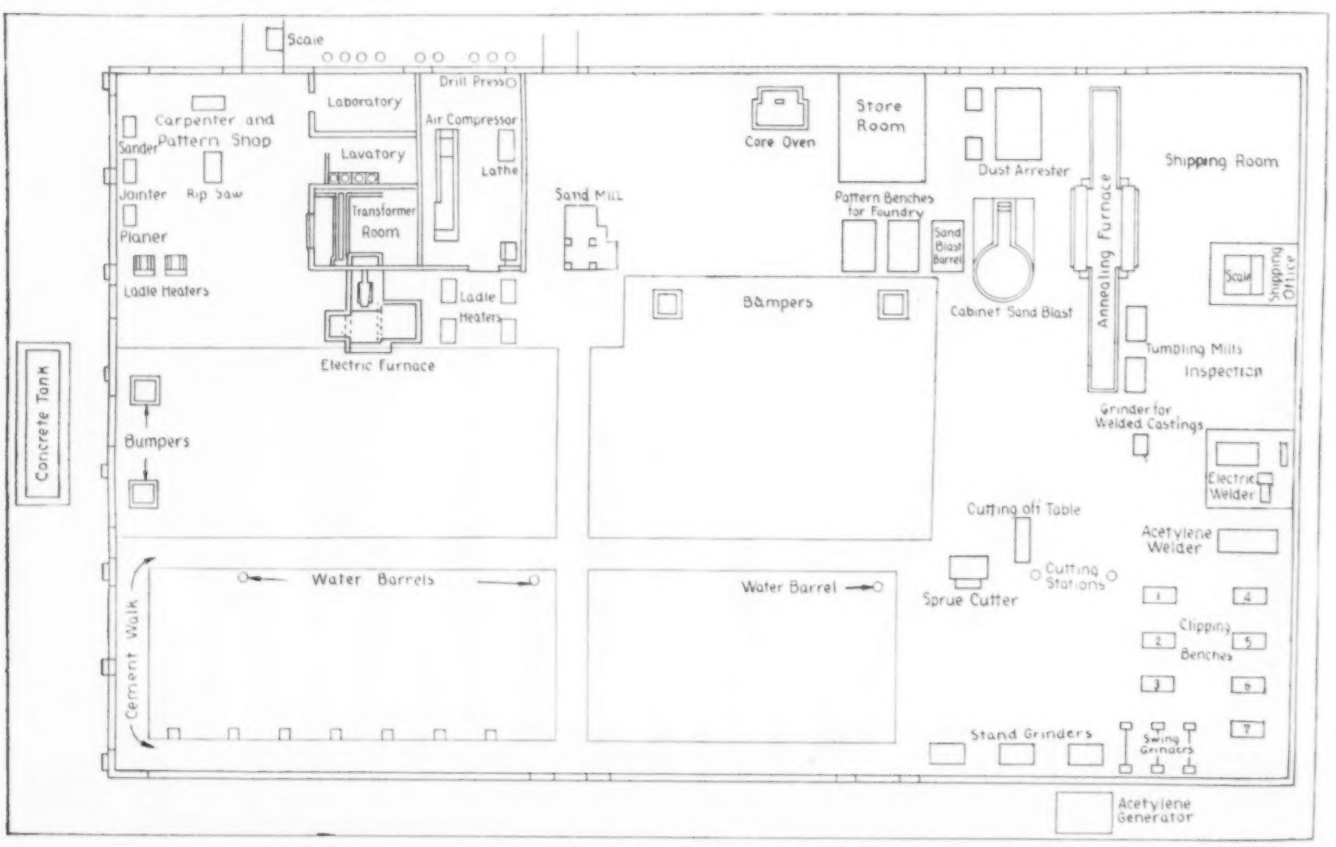


FIG. 9—LAYOUT OF THE NEW STEEL FOUNDRY OF THE BLACKWOOD ELECTRIC STEEL CORP., PARKERSBURG, W. VA. THE MAIN BUILDING, 139 X 230 FEET, IS ROOFED WITH TILE SLABS

volts by three transformers elevated from the ground between the main and storehouse buildings. High-tension leads pass through the tile roof and convey current to the synchronous motor which operates in connection with the electric furnace. All high-tension wires are suspended from the ceiling.

While the electric furnace shown in Fig. 5 is rated by the makers at 1½ tons, charges 3 tons and larger have been melted. The furnace operates on the 3-electrode, 3-phase system. Electric power received by the transformers is balanced theoretically and practically and permits no voltage disturbances and no introduction of harmonics into the transmission lines. The melting unit is lined with special-shaped refractory blocks which are so arranged that the furnace may be relined within two hours without requiring the services of an expert mason. While the furnace at present is being charged by hand arrangements have been made to install an automatic charging system.

Voltages to suit the exact refining and slagging conditions required for the most rapid and efficient operation are adjusted by a multi-voltage transformer. The furnace is fitted with new high-speed electrode regulators and winches and an automatic switchboard. It is tilted through gearing either by hand or by a roller bearing motor. In the slagging direction the unit may be tilted through 35 degrees and in the tapping direction through 45 degrees so that any cavity formed in the bottom may be drained readily of metal without excessive labor in rabbling or fettling by hand. The power consumption of this installation under operating conditions averages about 525 kilowatt hours per ton of liquid steel while the electrode consumption is averaging about 11 pounds of carbon per ton of metal.

Each heat of steel is poured into a 3-ton bull ladle tilted through helical worm gearing and is transferred to standards by an electric traveling crane which spans the middle bay. The standards are of the movable type and may be placed at any advantageous location. Any excess metal that remains in the bull ladle after the molds are poured is dumped into small scrap boxes on the floor near the pouring stand. After solidifying this metal is returned to the electric furnace.

Two gas-fired heaters shown in Fig. 5 are provided to keep the large bull ladles warm between heats The ladle rests on brick piers with its rim tight against a firebrick wall provided with an opening near the bottom through which the flame passes into the vessel. Near the top of the wall are two openings which provide for the combustion of excess gas. Air for combustion is supplied at 1-pound pressure by an electrically-driven steel plate blower installed in the power house. This blower also serves the annealing furnace, core oven and the furnaces used for the purpose of drying and keeping warm the small hand-shanked ladles.

Three ovens for heating the small bull ladles, as shown in Fig. 8, are built near the electric furnace. These are rectangular shaped with the combustion chamber running their entire length. Standards are provided on both sides and support the ladles in an inverted position directly over a small hole in the roof of the oven.

Large castings in the sequence of production are dumped on the floor by the aid of the crane and when as much of the core and sand is removed as possible they are transferred to the sand blast cabinet. From here they pass to the sprue cutting machine. In case the gates are too large to be cut by the sprue machine, the castings are taken to a cutting-off stand nearby where the sprues are removed by oxyacetylene torches. Inspection of the castings follows and they pass to the swing grinders and thence to the shipping benches. If further inspection uncovers any defects the castings are transferred to the welding department at the rear of the foundry where the electric and gas welding processes are used. In event welding is required the welded section is smoothed off by a high-speed grinder. Castings then are annealed and shipped.

The annealing furnace, 6½ x 16 feet, shown in Fig. 3, is installed at the rear of the foundry near the shipping department. The unit is operated continuously being equipped with a track which extends a suitable distance beyond each end, so that while a carload of castings is being annealed a car on the exterior may be loaded. All castings are annealed for four hours at a temperature of 1620 degrees Fahr. The furnace is equipped with a pyrometer.

Mills, Rhines, Bellman & Nordhoff, Toledo, O., were engineers in charge of the design and construction of the plant.

Commemorate Fiftieth Anniversary

An elaborately illustrated catalog with an historical introduction has been published by the Industrial Works, Bay City, Mich., to commemorate the fiftieth anniversary of its organization. The history of cranes is the content of the introduction. The locomotive cranes, their accessories, wrecking cranes, special railway equipment, pile drivers, and foreign cranes manufactured by the Industrial Works are fully described and illustrated in separate chapters. The locomotive cranes include rail traction and crawling tractor cranes from 5 to 60 tons capacity for operation by steam, gasoline or electricity and also barge wharf and gantry cranes. Buckets, grapples, magnets, generators, draglines, dipper arms, scale proof boilers, enclosed cabs, oil burners, lighting equipment and special booms are some of the accessories listed. Wrecking cranes for railroad or construction work are described with capacities ranging from 75 to 200 tons. The special railway equipment illustrated includes electric and hand operating transfer cranes, portable rail saws, and other maintenance equipment. Sections deal with the various models of pile drivers and illustrate the differences in the designs of equipment which export equipment requires.

Arc Furnace Operation Flexible

(*Concluded from Page 694*)

doors on the chamber side of the furnace wall, so that the ledge is on the outside rather than on the inside of them. Notwithstanding these defects, the installation has been a commercial success. Under the circumstances, a good life of refractories has been obtained. The second basic lining was apparently far from worn out when the basic period of operation was terminated; and at last report, about June 1, 1923, the first acid lining was in good condition. A new roof lasts about one month, that is, 50 or 60 heats, before requiring patching. It usually stands patching about twice, and lasts in the neighborhood of 3 months, or a total of approximately 150 heats.

Gives Foundry Course

The Cass Technical high school, Detroit, will offer a course in pattern making and foundry practice, leading to an apprenticeship with advanced standing or to credit in an engineering college. It is designed to give some understanding of the various types of work connected with the production of castings, together with a working knowledge of the principal types, including wood pattern making, metal pattern making and foundry procedure, embracing molding, core making, and cupola practice. The amount of time spent on shop work is two forty-five minute periods daily, except the third year, during which this amount of time is doubled. H. R. Jenney will be in charge of this department.

Foundry Costs Simplified--VI

Methods Outlined for Determining the Burden Charge, the Blanket Rate Being the One Most Often Used—Comparison of Actual Cost Made Monthly with Estimated Costs Show Profit or Loss

BY ALFRED BARUCH

IN bidding for work the burden is the part of the estimate that is most often ignored. At the same time, it is the part that the customer will challenge first. It is so elusive in its character that it is likely to make the difference between profit and loss if it is not determined properly. Even where the foundry burden is known it is often applied in the wrong way so that costs are arrived at which are unfair to competitors and unfair to the customers as well.

Many methods are used for applying the burden to the cost but the problem is to find the right one in each case. These methods are referred to as the blanket rate, the productive labor cost, productive labor hours, and the departmental or production center rate.

The blanket rate method is the one that is most often used. It makes the burden a proportion of the combined cost of labor and metal and assumes that the burden will rise or fall in proportion to the rise or fall in the cost of metal and labor. As a matter of fact the burden is fairly constant while the price of metal fluctuates continuously. For example, as a result of his past experience a foundryman decided to charge 30 per cent of the cost of labor and metal for burden. The cost of labor and metal for the year previous was $80,000 of which $30,000 was labor and $50,000 was metal. In the course of the year, metal takes a 50 per cent average drop in price. That means that the cost of labor and metal is $55,000 instead of $80,000. By charging a blanket rate of 30 per cent the return for burden is $16,500, when experience shows that it should be $24,000.

Blanket Rate Unsound

The chief objection to this method, in addition to the fact that it is unsafe, is that it favors cheap work at the expense of the costlier work. A man may ask for a bid on two kinds of iron for the same pattern. Under this method the cost of the job using the cheap metal will be so much lower than the cost of the one using higher priced metal that no one will be tempted to favor the higher price. A strange reason for not using the proper burden method but one which is often advanced is that no matter what methods you use, the price is really determined by competition and not by any figures you may have as to the cost of production.

Under the direction of production labor cost methods burden is applied to labor only. Labor costs are not so addicted to continual change as in the case of material. Applying burden to productive labor permits monthly comparison with actual expenditures. This cannot be done under the blanket rate method since the expenses do not vary in proportion to the cost of metal and there is no way of telling whether the expenditure is justified or not.

Make Definite Charge

Burden varies in proportion to the time of operation. This is true of the individual job. It incurs as much expense as it takes time in making. That is, if one order requires five heats it will take five days of supervision, insurance, rent, interest, taxes, etc. It is not fair to charge one job with all of these expenses because the rest of the foundry is not used to its full capacity. Therefore, a fixed charge must be made based on the time the men work on this particular job.

All men are not paid the same wages and burden cannot be based directly on wages because each man incurs approximately the same amount of indirect expense. For example, two molders may be getting different wages but they both require the same amount of supervision and space in which to work.

The departmental rate becomes necessary wherever the department uses heavy and expensive equipment that involves a considerable outlay of money for purchase and for maintenance. For example, a japanning department would require ovens, frames, and other equipment. It certainly would not be fair to charge a casting that does not have to go through this process at the same rate as one that does. Consequently, it is necessary to set up a special departmental rate and to charge each job that goes through the department at this rate on the basis of time required in going through or else on the basis of so much for each casting. The burden in this case must be made up of the interest on the investment, the insurance, this department's share of the property taxes, depreciation, rent in proportion to the floor space the department occupies, and then the regular departmental burden rate in addition. Where the foundry is large enough the same principle must be used for the sand blasting, cleaning, and repairing departments. If the molding department uses molding machines and requires special rigging the departmental rate must be used here as well.

Thus, it may be seen that one method is impossible all through a foundry unless the foundry does no jobbing work and devotes its entire time and effort to a stock product. For the average foundry the molding productive hours is the proper basis for burden distribution. But if a japanning or an annealing department exists, it is necessary to charge a rate for the department.

The departmental rate, or the productive hour rate, then becomes the basis for measuring the efficiency of the individual department. Where the productive hour rate is used this is done by taking the normal productive hours for a month and multiplying them by the rate. The result is compared with the actual indirect expense for that department for the month and the difference is carried to a reserve account where it is balanced against the differences of other months. That is, if last month showed a loss for the molding department of $250 and this month showed a gain over the standard of $300, the net gain for the two months would be $50.

Modern Foundry Analyzes

The statement has been made before that the chief difference between the modern method of managing a foundry and the old one is that now the foundry owner knows where he stands much oftener than he did before, and, in addition, he has the various elements of his business so analyzed for him that he can locate the trouble almost at once and correct it. He does this through a monthly report which tells him of the profit or loss that he has earned during the month, on the plant, on the individual department, and, if desired, on the individual job. The profit or loss on the plant is made possible through the use of a perpetual inventory or its substitute. The departmental profit or loss is made possible through a predeter-

MONTHLY COMPARISON OF JOB COSTS

ORDER NO	NAME	SALES	PROFIT & LOSS	LABOR COST		MATERIAL COST		INDIRECT EXPENSE	
				ACTUAL	ESTIMATED	ACTUAL	ESTIMATED	ACTUAL	ESTIMATED

FIG. 9.—THE INFORMATION FOR THE ACTUAL COLUMNS IS OBTAINED IN EVERY CASE FROM THE PRODUCTION ORDER ISSUED TO THE FOUNDRY

mined rate which when multiplied by the number of working hours shows whether or not the expenses for this department for a month have been exceeded, and also whether the predetermined rate is correct. The source of information for labor costs is the daily distribution of time sheets. The cost of metal at the spout as shown by the foundry clerk's weight reports on his copy of the production order furnish the metal cost. The burden cost has just been explained.

Monthly Comparisons

All the elements of cost are thus collected in one way or another. A comparison of the actual cost of each job with the estimated cost of it is brought about through the form known as the Monthly Comparison of Job Costs. This form is divided into columns headed order number, name, sale, profit, loss, labor cost, material cost, and indirect expense, as indicated in Fig. 9. The column headed order number should contain the order number of each job, and the name of the customer should appear in the name colume. The figure at which the job was taken shows next, if the job was complete at the time the statement is made. If the order is only partially complete the figure in the sales column represents the value of the work completed to date. Profit or loss in this case is the difference between the sales figures and the total of labor, metal, and burden costs. The labor, metal, and burden costs are again subdivided into two sections headed actual and estimated. The information for the actual column is obtained in each case from the production order issued to the foundry. The burden estimated is the indirect expense allowed for in the original bid. The actual burden rate is the same as the predetermined, but multiplied by the actual labor hours consumed by the job. That is, we will assume that the order was taken on the basis of 50 molding hours which would require fifty times the hourly labor rate, plus fifty times the hourly burden rate to make the total of burden and labor for this job. However, if the work took 55 hours instead of 50 the labor and burden will each be higher by five times their respective hourly rates.

This job costs form is intended to bring together on a single work-sheet the cost of operating by jobs or by customers. However, not all jobs are started and finished within the same month. Consequently, all jobs that are finished in the current month but have been started in the previous one show on this report only that portion of the job which was completed during the month. Similarly, all jobs started this month would not be completed but would be represented by figures which cover only this month's operation. By this method the profit or loss on work in process is projected so as to enable the foundry owner to see how each job is coming through. The profit or loss for the whole shop will be taken care of in another manner, but the prime cost necessary to this report must be obtained from the work order, and the burden can be found by multiplying the predetermined rate by the labor hours, if the production hour method is used, or by the unit or departmental hours, if those methods are used. For example, assume that job number 110 is obtained for $5000 and called for 100,000 pounds of castings of a uniform pattern. Half of this job is complete at the end of the month and the sales figures for this part would naturally be $2500 of which $250 is allowed for profit, $600 for burden, $500 for labor, and $900 for metal. The actual figures are $850 for metal, $480 for labor, $550 for burden, $185 for office expenses, which leaves $435 for profit instead of $450.

Shows Profit or Loss

However, this method shows only profit or loss on the individual job. The total profit or loss for the month is determined in the following manner: An itemized statement of all indirect expenses by departments is made. This statement follows the form indicated in Article V, published in the Aug. 15 issue with the exception that it makes a comparison, item by item, with the standard cost. For example, the analysis of molding burden in Article V shows the average figures for each ex-

MONTHLY COMPARISON OF MOLDING BURDEN

ORDER NUMBER	EXPENSES	THIS MONTH	STANDARD	INCREASE	DECREASE
	LABOR				
300	Foreman (70 per cent of $225.00)	157 50	157 50		
301	Cutting sand and preparing floors (4 men)	700.00	700.00		
302	Pattern makers (2 men)	270.00	270.00		
303	General help (8 men)	780.00	780.00		
304	Special help (engineer)	40.00	40.00		
	SUPPLIES				
320	Molding sand (25 tons at $5.50)	139.00	137.50		1.50
321	Flasks, wood	510.00	500.00		10.00
322	Small tools	48.00	50.00	2 00	
323	Nails	6.50	5.00		1 50
324	Parting (2 bbls. at $16.60)	36.00	32.00		4.00
325	Plumbago (1 bbl. at $27.00)	35.00	27 00		8.00
326	Chaplets	3.00	1 50		1 50
327	Miscellaneous supplies	16.00	10.00		6.00
	APPORTIONED EXPENSES				
	Compressed air (10 per cent of $450.00)	50.00	45.00		5.00
	Defective work (80 per cent of $400.00)	320.00	320.00		
	Heat (33 per cent of $270.00)	89.00	89.00		
	Light (30 per cent of ($200.00)	60.00	60.00		
	Power (5 per cent of $600.00)	40.00	36.00		4.00
	General expense (50 per cent of $2400.00)	1200 00	1200.00		
	Total	4500.00	4460 50	2.00	41.50

FIG. 10.—IN MONTHLY STATEMENTS THE AVERAGE EXPENSE IS PLACED BESIDE THE CURRENT COST OF EACH ITEM TO DETERMINE INCREASES OR DECREASES

pense per month. In the monthly statement this average is placed side by side with the actual expenses and the increase or decrease for the month is shown in the adjoining column, as indicated in Fig 10. When the actual expenses have been totaled the predetermined rate per molding hour is multiplied by the number of productive labor hours in the molding department for the month, and the result is compared with the actual burden to see whether or not enough has been earned this month to cover the department's expenses. For example, we will assume that the expenses for the month have been $4500 and the molding hours ran to 7000 hours. The predetermined rate in the illustration given in Article V was 70c per hour, therefore, the burden earned this month is $4900 while the expenses amount to $4500, showing a burden profit of $400.

The total actual and standard figures for each department are carried to a sheet known as the Monthly Comparison of Foundry Costs, as indicated in Fig. 11. The totals of each department are added, making a total foundry burden. To this is added the direct labor cost, the metal purchased, and the inventory at the first of the month. From the total of these figures the inventory at the end of the month as shown by stock records is subtracted to give the net foundry cost for the month. To the net foundry cost is added the office and selling expenses and this gives the total cost for the month. The total cost is subtracted from the sales for the month as shown by the Monthly Comparison of Job Costs, which gives the foundry's profit for the month; that is, the profit on operation alone.

MONTHLY COMPARISON OF PLANT COSTS				
ITEMS	CURRENT MONTH	AVERAGE MONTH	INCREASE	DECREASE
DEPARTMENTAL EXPENSES				
MELTING				
CORE MAKING				
MOLDING				
SAND BLASTING				
CLEANING				
REPAIRING				
JAPANNING				
COMPRESSING				
GENERAL EXPENSES				
TOTAL PLANT BURDEN				
DIRECT LABOR COST (Payroll)				
MATERIAL PURCHASED THIS MONTH (Purchase Book)				
PLUS INVENTORY AT FIRST OF MONTH (Stock Record)				
TOTAL				
LESS INVENTORY AT END OF MONTH (Stock Record)				
NET PLANT COST FOR MONTH				
SELLING AND ADMINISTRATIVE EXPENSES				
TOTAL SELLING AND ADMINISTRATIVE EXPENSES				
TOTAL PLANT BURDEN				
PREDETERMINED RATE X DIRECT LABOR COST				
OVER OR UNDER ABSORBED BURDEN				
TOTAL OFFICE EXPENSE				
PREDETERMINED RATE X SHOP COST				
OVER OR UNDER ABSORBED OFFICE EXPENSE				
RECONCILIATION OF PLANT COSTS				
NET PLANT COST PER MONTH				
OFFICE EXPENSE				
TOTAL COST FOR MONTH				
TOTAL SALES FOR MONTH (Sales Book)				
LESS COST				
MANUFACTURING PROFIT FOR THE MONTH				

FIG. 11.—FROM THE TOTAL OF THESE FIGURES THE INVENTORY AT THE END OF THE MONTH IS SUBTRACTED TO SHOW NET FOUNDRY COSTS

Interest as a part of the cost has been the occasion for much debate and a word must be said about it. Interest is usually confused with profit. Profit is what is left after all expenses and charges have been paid. It is a reward to a business man for taking the risk of engaging in business. It is true that a man cannot govern the price by including interest in his cost and that the mere act of his charging interest does not mean that he will get it back in his price. But neither does charging his salary or rent mean that he will get them back. That is the risk that he takes when he goes into business. However, the fact that he will not get it back does not mean that it is not part of his cost. If a man should borrow money to operate his business he would certainly have to pay interest on it before he could declare a profit.

Rent and interest are much alike. A man pays rent when he has not the money to buy the building he needs. He may prefer to borrow the money and buy the building rather than to pay rent on it. In that case, interest on the borrowed money would become a substitute for his rent. Or suppose that a foundryman wishes to substitute molding machines for hand molders and that in order to do this he must borrow the money with which to buy the machines. The interest that he has to pay for the borrowed money in this case becomes the substitute for labor wages that he has paid. Thus interest is really a part of the cost, and the conclusion is forced on us that interest on the foundry investment is inseparably a part of the foundry cost.

Another part of the cost that is often ignored is depreciation. Equipment wears away or becomes obsolete and provision must be made to replace it. It is not enough to think that the earnings will take care of replacements. A reserve fund must be set aside with which the new equipment can be bought. This action is necessary to keep the foundry up to the latest developments in foundry practice if for no other reason.

To provide for a depreciation reserve it is necessary to find a systematic method of evaluating the wasting of assets. The two best methods are known as the schedule-rate and the percentage-on-value methods. The schedule rate method makes a flat charge every year. Assume that a piece of equipment is worth $1000, and that its expected life is 10 years at the end of which time it should be worth $100 as scrap. The re-

maining $900 are divided by 10, which gives a yearly rate of $90.

The percentage-on-value method would take a certain figure, say 10 per cent of the appraised value every year as the basis for depreciation charges. In the case cited, at 10 per cent the first year's charge would be $100, the second year's charge would be $90, which is 10 per cent of that year's valuation of the equipment considered; the third year would be $80, and so on.

The following is an estimated set of rates on the major foundry equipment to indicate the usual expensive light.

	Rate of Depreciation Per Cent
Tumbling barrels	10
Babbitt bearings	Expense
Roller bearings	10
Roller exhaust	10
Roller system	10
Brick buildings	3
Concrete buildings	2
Wooden buildings	5
Burners	½
Truck for the oven	10
Chemicals, laboratory	10
Air compressors	7½
	10
Crane track	5
Crane swing	7½
Traveling crane	7½
Steel cupolas	5
Separators	7½
Elevators	7½
Engines	5
Ventilating span	7½
Flasks, iron	10
Flasks made of wood are treated as expense.	
Forges	5
Crucible furnace	10
Grinders	7½
Hand grinders	20
Swing grinders	10
Heaters	10
Poles	10
Building machines	7½
Sand blasters	10
Mixers	10
Wooden shelving	5
Wooden tables	10
Vises	10
Welding apparatus	10
Wires, cutters, etc.	10

Gear Molding Rig Cuts Pattern Expense

AMONG the first molding machines used in the foundry were those for gears and these machines have been highly developed since the original ones were built. Many varieties of gears and gear teeth would require a vast assortment of patterns and this has formed the incentive for building molding machines which do not require solid patterns but can produce gear molds from small sectional pieces. One of these machines is used in a large steel foundry which secured its first gear molding machine from England and has since added other machines secured in this country.

As may be noted this machine requires only a small sectional pattern for forming the teeth, two teeth being molded at a time. To start the mold the flask is set on the bed of the machine so that all points on the edge of the flask are equally distant from the axis of the machine bed, the center of which revolves. The bed of the mold is swept up about a spindle, care being taken to see that it is perfectly level. After the bed is made the square stand shown near the center in Fig. 8 is bolted to the revolving table and the molding arm is clamped to it. The distance this arm protrudes from the central axis determines the diameter of the gear. This distance is measured by a finger point, *A*, and the distance the arm protrudes from

THE PATTERN IS MOVED IN AND OUT WITH THE LEVER ON THE ARM WHICH IS SWUNG IN A CIRCLE BY THE REVOLVING TABLE TO WHICH IT IS ATTACHED

the axis is then regulated by moving the center block along a groove in the table. When the molding arm is set, a board, *B*, is placed on one side of the pattern and the board held in the hand of the molder is adjusted on the opposite side with the weight *D* set against it to support it. The mold is then rammed, making two teeth. To move the arm the molder pulls the lever, *C*, which draws the pattern away from the mold on guides and allows the arm to be swung to set the pattern for making the next two teeth. Now the sand of the part of the rim which has been molded acts as a stop on the one side of the pattern and a board is used on the other side of the pattern only. The pattern which is clamped to the end plate of the molding arm is easily changed when a different sized gear is to be made.

After the teeth are formed the flask is taken with the crane to an oven and dried, or it is carried to the molding floor and skin dried. Then cores are set to form the inside circumference of the gear which does not have arms but is bolted to a spider for use. The distance of the cores from the teeth is measured with a templet and the cores are backed up with molding sand. Being set on the bed swept on the bottom plate the cores are held straight and perpendicular. Cover cores are used to form the upper edge of the rim. Occasionally the cores are cut radially at the ends to conform to the circle of the wheel, but a better method and one that is practised extensively both in iron and steed foundries, is to form the end of the corebox in the shape of an arc of a circle.

FAKED FOUNDRY FACTS

A FOUR PART JOB

Leaky Water Jackets Due to Several Causes

Question: We are having trouble with some of the water jackets we make for stoves and ranges. We have changed the location of the runner at different times but still the castings leak. Our cupola is lined to 28 inches and the blast is supplied by a 40-inch pressure blower direct connected to a 15-horsepower motor running at 3400 revolutions per minute. With the blast gate throttled down the iron melts very hot, but when the gate is wide open the iron melts too fast and also is cold. Do you think the iron is oxidized under these conditions? The tuyeres are 12 inches above the sand bottom and the coke bed is 22 inches above the tuyeres. The charges are made up of 500 pounds of iron and 60 pounds of coke. Our order specified a cupola having a charging door 12 feet from the base. The manufacturer supplied one with the charging door 12 feet from the ground and only 9 feet from the base and we are wondering if that makes any difference. We melt nothing but scrap iron but it is the best machinery scrap we can get in this part of the country. If it was not for the fact that other foundries in the vicinity use the same kind of iron we should be inclined to ascribe our casting losses to this cause. We shall be pleased to receive any advice or suggestions that will help us to overcome this trouble.

Answer: We assume that you are referring to the casting sometimes flat and sometimes L-shaped forming part of the stove lining and used for the purpose of heating the water in an adjoining tank. In different localities it is known as a water-back, a water-front, a water-heater and a water-jacket. Three principal causes are responsible for these castings leaking. The leak may be due to one or two, or even all three of these causes. The iron may be oxidized in the cupola; dirt or slag inclusions may have flowed into the mold with the iron; wet sand or an excessive use of the swab may cause the iron to boil in the mold. By breaking one of the castings in several places and examining the fracture closely the cause of the trouble will be fairly obvious.

If the casting shows a profusion of little cavities, colored different shades of blue and purple, it is evidence that your iron is burned or oxidized. The remedy is to raise your bed, place a little more coke between the charges and possibly reduce the blast. The second cause of leaky castings, dirt or slag inclusions in the iron, is the most frequently encountered of the three. The evidence of the condition plainly can be seen when the casting is broken. Usually the dirty spot will be found in the vicinity of the gates, at the corners, or around the chaplets. In extreme cases they may be found at almost any point. Sometimes it is impossible to decide whether the dirt is composed of slag that flowed in with the iron, or is made up of loose sand or blacking from the face of the mold or core. It is almost impossible to detect small quantities of slag floating on top of a ladeleful of extremely hot iron. For that reason the iron should be stirred and carefully skimmed before pouring one of these castings. The remedy for dirty grates or mold, or for a grade of blacking that washes before the stream of iron, is obvious and needs no comment.

Wet sand, whether the result of adding too much water in cutting over the heap, or in a too liberal application of the swab before and after drawing the pattern, will produce a porous casting. The steam generated is trapped by the molten iron and the broken casting will show a honeycomb of small, bright, shiny cavities. In some cases the ebullition is quite violent.

Bill On The Subject Of Favorite Books

BY PAT DWYER

FOR some time past one of our local papers has been running a brief article every morning under the caption My Ten Favorite Books. Each of the articles is presented in the guise of an interview with some more or less prominent person and the views set forth have shown a wide divergence of taste. One peculiar feature about the entire series, so far as I have been able to observe, is that while many eminent authors of books have recorded their impressions, not one has included one of his or her own books in the collection. What is still more singular is that not one has mentioned a single work of any contemporary writer.

One readily can understand that a due sense of modesty might prevent an author from singing the praises of his own work, but I confess I am at a loss to understand why he should be reticent in saying a kind word for the work of a brother craftsman. It may be that the ethics of the profession forbid anything of this character and if such is the case it certainly speaks well for the *esprit de corps* of the association to see how well the members restrain themselves. I trust I am not one of those unduly suspicious characters always ready, willing and even anxious to impute improper motives where none exist. Far be it from me to hurl the first rock from the sling of suspicion. I have a lively appreciation of the trials and tribulations of those who live in glass houses, but strictly between ourselves, I am beginning to lose faith in the printed word, particularly as it appears in syndicated stuff in the daily papers. Among the newspaper people it is known as boiler plate. Now then children, all together, let us sing it: boiler plate for hard boiled terriers.

Several of those who were interviewed contented themselves with merely submitting a list of the ten titles. Others spread themselves over the better part of half a column—if it is safe to say that one part may be better than the other—explaining in detail the reasons for selecting a certain ten in preference to thousands of other books which they modestly admitted having read at one time or another.

Others again, with that peculiar mental twist which characterizes some people and which leads them to evade the spirit and still remain technically within the letter of every contract, agreement and transaction, present lists that would have puzzled Professor Elliott to squeeze on his famous five-foot shelf.

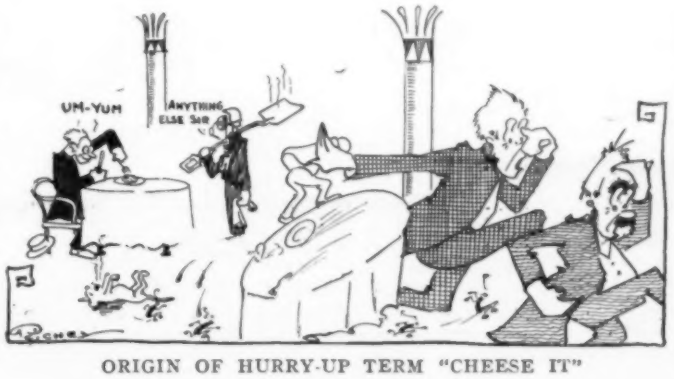
One ambitious gentleman included the works of Dickens, Shakespeare and Thackeray and then listed seven other books from which he claimed that he had drawn inspiration and pleasure. Any ordinary man who has been beguiled by his wife into buying a complete set of the works of any of these old masters, one dollar down and the rest in 23 monthly installments which generally extend over a period of ten years, knows that he also required at least seven sections of a collapsible bookcase in which to house them.

I directed Bill's attention to a list made up in this manner and asked him if he thought I would be justified in filing a formal protest. I wanted to write to the author direct and ask him if he was quoted correctly, and if so what had he to say for himself.

"All piffle" said Bill "You only waste your time reading that kind of bunk and why you should want to waste further time only can be explained on the strength of a certain hymn which carries lines to the effect that Satan still can mischief find for idle hands to do. Taste in books is like taste in food or clothes. It is individual to ourselves and is not affected by the taste of other people. I know a man who is partial to a certain species of cheese and frequently includes a portion in his lunch. He claims that the flavor, the bouquet, appeals to him in a manner that is not equalled by any other form of food and on several occasions when we have lunched together, has attempted to persuade me to sample a small portion.

"The stuff looks to me like the mortified remains of something decayed and I would not touch it unless I was fortified with a gas mask, a pair of rubber gloves and a pair of long handled blacksmith tongs. The food probably is good, but I have no desire to eat it and I am sure my opinion would not change even if I saw it listed as the favorite food of the ten most prominent men that ever lived. I cannot conceive of any real lady eating it, and therefore I am relieved of the necessity of including them in this comparison.

"The same is true of books. The fact that Horatio B. Holtott claims that he enjoys reading An Analytical Study of the Relative Merits of Sheep Dip and Tobacco Juice as a Substitute for Potheen, by Professor Worm, would



ORIGIN OF HURRY-UP TERM "CHEESE IT"

not arouse in my mind any violent desire to lay hands on a copy and the same practically is true of every book I have seen listed as a favorite of some particular person.

"If any person was moved sufficiently by curiosity or any other motive to interview me I could furnish a list of ten favorite books and by favorite books I mean books that I have read voluntarily more than once. I have read other books more than once, but certainly not of my own free will and even at this late date I should experience no difficulty in recalling the titles or compiling a list of several books that I detested cordially. However, it is exceedingly problematical whether I should get more than one or two hardy souls to admit that my latter list appealed to them and therefore I shall lose no sleep or peace of mind if it never appears. Although I have no desire to obtain a little brief notoriety by bursting into print over a list of the ten most disagreeable books in the English language, still I think I could compile the list more easily than if I was confined to a list of the best ten.

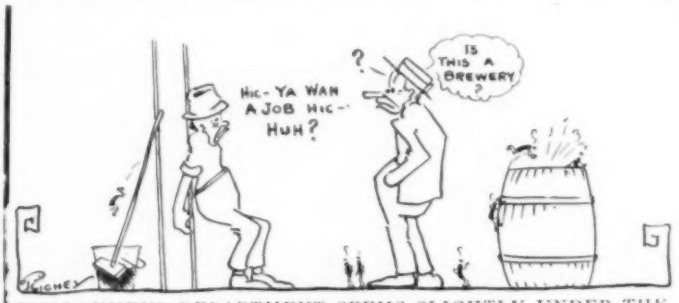
"I have one book especially in mind that would head the procession. In addition to causing me more trouble than any other, it was perfectly useless in fulfilling the purpose for which it was intended. It was the product of a highly cultivated, theoretical young man who apparently believed that the sole end and aim of a manufacturing plant is the collection and tabulation of statistics.

"The fact that the information gained from the statistics never is applied, or at best only is available long after the conditions that seemed to warrant the compilation of the figures, have passed away, never seem to affect birds of this kind. They are just as happy fussing over a bunch of figures as a setting hen trying to hatch out a collection of china door knobs—and just about as useful.

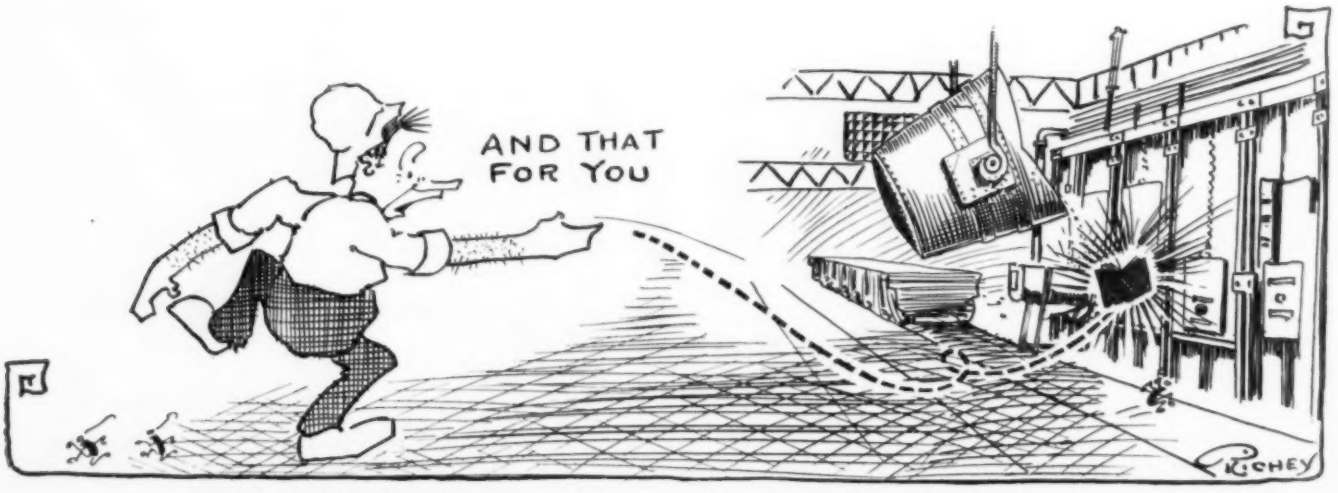
"After I had rambled around the country for several years bumping the bumps and seeing the sights I drifted into a town where a new iron and steel producing plant had been established. To insure a supply of castings for the blast furnaces, open-hearth steel furnaces, rolling mills, coke ovens and other departments, the company erected a set of shops and then set about recruiting a sufficient number of workmen to man them.

"I blew in there several months after the first heat had been taken off and just about the time the quota was filled. In fact I had some slight difficulty in persuading the gaffer that he needed my services. He was leaning against one of the posts supporting the crane runway and favored me with a fierce and disconcerting stare as I approached. In the expressive, if somewhat vulgar language of the period he was *pickled to the eyes.* I told him I wanted a job and he told me to fly to a place which has a reputation of maintaining a temperature all the year around considerably higher than that in the average steel foundry. He said that he had more men than he possibly could look after and he certainly had the appearance of a man telling the truth. I found out afterward that most of the harum-scarum gang exhibited the same characteristics, but they gradually oozed out of the shop and out of the town and were replaced by workmen of a more desirable type. I went in to work on the following morning and when the ex-pickled herring saw me walking off with a pattern he wanted to know who and what I was and where I thought I fitted. I told him he had hired me on the preceding day and had indicated the pattern on which I was to commence work. He was reasonably certain, or as nearly certain as any person in his previous condition could be, that he had not hired me, but in the face of the evidence I presented, he capitulated and had the timekeeper enter my name on his book.

"Now don't get up on your favorite high horse and read me a long winded lecture on honesty in business and the sacred character of the relationship that should obtain between employer and employe. 'Tis true this man represented the company and had the privilege of hiring and firing the men in his department, but was almost habitually drunk and therefore, according to my somewhat primitive way of sizing up the situation his services were of precious little value to the company. As a result of my training and experience I think I can fairly lay claim to the distinction of being a skilled molder in those days and for this reason, the company received a fair return in exchange for every day's wages paid me. I know that in the established order of industrial life it is considered rank heresy for an ordinary workman to set up his judgment in opposition to constituted authority, but I also have known of many instances where that



EMPLOYMENT DEPARTMENT SEEMS SLIGHTLY UNDER THE WEATHER



ONE OF THE REASONS WHY A HEAT OF STEEL SOMETIMES IS CALLED WILD

same constituted authority in the shape of an incompetent foreman was more of a liability than an asset. In this instance he did not last long. He had the official can tied to him about a week afterward and was succeeded by a more competent man.

"Conditions gradually adjusted themselves and in the course of a few years an efficient mechanical organization was built up that compared favorably with that in any similar plant. Following the advent of a new and enthusiastic master mechanic, the scope of the foundry's activities was extended to embrace the production of steel castings. Since I was the only man in the shop with experience along that line, an experience gained during my tourist days, I was commissioned to select a few men, proceed to the open-hearth department half a mile away from the foundry and get the business under way.

"We had our own troubles. We were regarded by the open-hearth people as interlopers and treated as a public nuisance. The master mechanc interviewed the general superintendent of the plant and made application for crane and furnace service. He was assured that we would have no trouble in securing either or both.

"In every large organization a general order that starts at the top pursues a long and tortuous course before it arrives at the bottom. By the time this particular order filtered through to the boss melter on each shift it had been diluted to a considerable extent and these men interpreted it to mean that if a few crumbs of crane or furnace service were left over, we might have them. The cranemen received their instructions and quite naturally trimmed them a little closer to the scalp. So long as they had any semblance of an excuse to refuse a lift they calmly ignored us.

"Any one of our individual lifts rarely occupied the time of a craneman more than a few minutes and yet I have seen those birds sit up in their cages for 15 minutes at a time doing nothing on the pretext that they were expecting hot metal from the blast furnaces or the mixer; one of the open-hearth furnaces was going to tap, slag pans had to be lifted out of the pits; the bricklayers wanted a cage shifted and when everything else failed they decided that the main hoist was desperately in need of a general oiling.

"Looking back now I realize that I was foolish to worry over conditions over which I had no control, but there were times when if I had the opportunity I cheerfully would have manned a machine gun and blown one of the obnoxious birds right—out of his nest.

"After the molds were dried and made ready, we were handicapped in getting them poured. Sometimes the heats were a trifle cold and the boss melter refused to take a chance in leaving a long line of ingot molds to come down to our corner to pour a few castings. So long as he could slap the steel into the ingot molds in rapid succession the stopper would work satisfactorily, but in the comparatively long journey to and from our molds the nozzle might freeze and cause endless trouble in pouring the remainder of the ingots. At other times a leaky stopper developed over the first ingot mold and it was out of the question to bring a ladle in that condition down to us. Again, conditions apparently might be favorable at the time the heat was tapped, but just before the ladle was swung out to travel down our way a string of hot metal ladles from the blast furnaces would be shunted in through the end of the mill and left in a position that prevented the steel ladle from being lowered down to pour our molds located on both sides and close to the track.

"Our space was limited and I had to keep shifting men constantly from one job to another while they were blocked temporarily for a lift or waiting to get a casting poured and thus release a certain flask. A man might have his drag rammed by 10 a. m., but he might not get a crane to roll it over until noon. By the time he had his parting made, the crane was gone and might not be available again for any period ranging from one to 10 hours. The same condition obtained in placing the cope, lifting it off, drawing the pattern, loading and unloading the oven car. We made castings ranging in weight from a few pounds up to 15 tons and it was a constant puzzle to keep the men employed constantly owing to the erratic and highly aggravating crane service.

"The last straw was laid on the burden when Willie Brighteyes, the long legged chief clerk in the master mechanic's office decided to find the cost of the steel castings. He had a book nicely ruled and sent down to me in which I was to enter the actual time spent on each job. If the shop had been self-contained, provided with its own crane and furnace so that the sequence of operation could be anticipated and controlled, I am willing to admit that his plan might have been carried out. If the work was of a standardized or routine character so that each man could work without interruption all day I might have been able to make an intelligible record. The foundry foreman brought the book down to me and when I asked him how in the name of high and holy heaven I was going to keep it in the face of existing conditions, what do you think he said to me? 'God knows. Do the best you can.'

"I kept an approximately accurate record for about a week and by that time I don't believe that the angel Gabriel himself could have made head or tail, beginning or end of the thing. The book was ruled in such a manner that the workman's name appeared in the first column and the pattern number of each job on which he worked during the day was to be entered after the name. If I had been working alone, the final record might have been unravelled, but with a half a dozen men shifting back and forth all day and working for varying periods on probably 20 molds the record was hopeless.

"For example, to find the elapsed and actual time on any mold the investigator would have to examine every page over a period of probably a week. He would find opposite every man's name, one or more items of time every day charged against that particular job. Then he might have to hunt through four or five pages before he found an entry to the effect that the casting had been poured and shaken out. I am heartless enough to admit that it would serve him right if he finally found that the casting was scrap.

"About a week after this interesting little experiment was wished on to me I intercepted the master mechanic one day and made an impassioned plea to be relieved either of the book or the job. I told him I was a molder and not a trick bookkeeper and if he wished the record continued he would have to supply an artist to handle the book. Since he seemed to be interested I expanded a trifle on my original plan and furnished a free and frank expression of opinion touching on the book and the man who made it. In support of my contention I showed him the precious volume and asked him what he thought of it.

" 'Throw it away' said he, 'I can find a more simple method than that to find what these castings cost.'

"I took the book around to the front of No. 1 furnace and when one of the helpers raised a door to throw in some ore I fired the book in on top of the bubbling steel. It may sound cruel and heartless now, but at the time I cheerfully could have seen the author following the book.

"Subsequently the men's time as taken from their clock cards was compiled over a given period and charged against the weight of good castings produced in the same period. In this manner an approximately average cost per pound was obtained and that was all that was required in the first place.

" 'In recent years', said Bill in conclusion, 'on several occasions I have regretted my hasty action in destroying what I now realize was a priceless

treasure. I have experienced some difficulty in maintaining my views on practice vs. theory which I could have won, hands down, if I only had that precious volume on hand to submit as evidence."

Start European Tour

Arrangements practically have been completed for the international foundrymen's congress and exhibition to open in Paris, Sept. 2. A number of those prominently identified with the foundry and allied industries in America made up the official party which sailed from New York on the LEVIATHAN, Aug. 18. These together with a few who have preceded them and others who are planning to follow by other routes will make up a group which will be warmly received and entertained in England and on the continent. Those who are making the tour include:

G. H. Clamer, first vice president and general manager, Ajax Metal Co., Philadelphia, president American Foundrymen's association.

Stanley G. Flagg Jr., president, Stanley G. Flagg & Co., Inc., Philadelphia, vice chairman, American Foundrymen's association tour committee.

L. L. Anthes, president, Anthes Foundry, Ltd., Toronto, Canada.

C. Barnhill, assistant superintendent, Fay & Scott, Dexter, Me.

E. W. Campion, assistant superintendent, Buckeye Steel Casting Co., Columbus, O.

W. E. Dunn Jr., secretary, Southern Metal Trades association, Atlanta, Ga.

C. H. Gale, formerly superintendent, Pressed Steel Car Co., McKees Rocks, Pa.

C. S. Gilbert, superintendent, Canadian Iron Foundries, Ltd., St. Thomas, Ont.

John Hill, president, Hill & Griffith Co., Cincinnati.

Jesse L. Jones, metallurgist, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

G. W. Knotts, United Engineering & Foundry Co., Pittsburgh.

Peter J. Krentz, works manager, Buffalo Foundry & Machine Co., Buffalo.

Henry M. Lane, president, The H. M. Lane Co., Detroit.

L. Sexton Lehmann, S. B. Sexton Stove Mfg. Co., Baltimore.

James Linklater, superintendent, Michigan Malleable Iron Co., Detroit.

J. S. McCormick, president, J. S. McCormick Co., Pittsburgh.

Verne E. Minich, president, American Foundry Equipment Co., New York City.

Dr. Richard Moldenke, Watchung, N. J.

W. H. Nicholls, president, W. H. Nicholls Co., Inc., Brooklyn, N. Y.

C. S. Snyder, vice president, Pittsburgh Rolls Corp., Pittsburgh.

Robert E. Turnbull, Chicago representative, Arcade Mfg. Co., Freeport, Ill.

August Van Lantschoot, metallurgist, Iowa Malleable Iron Co., Fairfield, Iowa.

George H. Wadsworth, president, Wadsworth Core Machine & Equipment Co., Akron, O.

R. H. West, president, West Steel Casting Co., Cleveland.

Walter Wood, R. D. Wood & Co., Philadelphia.

Many of the business men are accompanied by their wives, daughters or other members of their families. A number of American manufacturers of foundry equipment and supplies have sent special representatives ahead to pursue an individual itinerary, joining the main party at some place along the route or at the convention.

How and Why in Brass Founding

By Charles Vickers

Facts About Monel Metal

What can you tell us about monel metal? We would like to learn where it is manufactured and by whom, and what is the market price of bars and sheets.

Monel metal was discovered and patented Jan. 30, 1896 by Ambrose Monell. It is described as an alloy of nickel and copper obtained by reduction of the ore. The United States Navy specifications for cast monel metal are; nickel 60 per cent; manganese 2 per cent; iron, not more than 3 per cent, and the remainder copper. The bureau of steam engineering specifies; copper, 33.0 per cent; nickel, 60.0 per cent, minimum; iron 6.5 per cent; aluminum 0.5 per cent; lead, none. The melting point of monel metal is 2480 deg. Fahr., so for casting purposes a furnace capable of reaching a high temperature is necessary, and the mold facing must be sufficiently refractory not to fuse onto the castings.

The price of Monel rods, hot rolled is given by the *Daily Metal Trade* as 40c per pound, that of sheets as 45c per pound for the first week of the present month.

Brass Mixture Free from Pin Holes

We desire to learn the proper mixture of brass for castings to make them free of pin holes. We use scrap metal of ¼-inch section to the extent of 80 per cent of our mixtures.

As we are not given the analysis of the 80 per cent scrap metal that is being used we are unable to instruct what additions should be made to bring it to a standard analysis.

A good mixture to work to is copper 85 per cent; tin, 5 per cent; zinc 5 per cent; lead 5 per cent, when the castings are to be made of red brass.

If the scrap metal is yellow brass of 70 per cent copper, 30 per cent zinc, and the castings are of yellow brass make the mitxure according to the following formula.

YELLOW BRASS MIXTURE

	Per cent
Yellow brass scrap (70-30)	80.00
Copper	16.00
Tin	2.00
Lead	2.00

The above mixture will produce castings free of pinholes if melted under a covering of charcoal in the case of crucible melting. It is not necessary or desirable to add phosphorus.

Aluminum for Parts of Pressure Cookers

We desire to learn if at any time there has been published in past issues of THE FOUNDRY *articles on the subject of pressure cookers dealing especially with the various metals used in making such articles, such as the aluminum body and cover, and the brass parts such as lugs, nuts and safety valve.*

No articles have been published in past issues of THE FOUNDRY on the subject of pressure cookers. As far as the aluminum body is concerned, an alloy that will retain the pressure is absolutely necessary. A good grade of No. 12 alloy may do this, but it is not generally regarded as a pressure-resisting alloy, and therefore, it is likely that a large percentage of the castings made will be leakers. An alloy of 96 per cent aluminum, 2 per cent copper and 2 per cent magnesium would be preferable, not only because it will hold pressures but because the less copper the better. The brass parts would contrast well with the aluminum body, if made of yellow brass such as copper, 70 per cent; zinc 26 per cent; tin 2 per cent, and lead 2 per cent. Or if a red brass is preferred such an alloy as copper 85 per cent; tin 5 per cent; zinc 5 per cent and lead 5 per cent is a very good one to use.

We note that you desire information that will be a help in producing a better cooker, but THE FOUNDRY is only concerned with the production of castings, and does not consider their design, it may be pointed out though that the design of all *pressure cookers* leaves much to be desired and a great amount of thought can profitably be expended on their shape, keeping in mind the fact that the housewife is not an engineer used to

the operation of autoclaves, and that the vessels heated in the cooker are not easy to remove therefrom with present shapes. It would be well to study also the effect of the higher temperatures obtainable with such cookers, on the vitamines in the food to be prepared with facts to answer some of the questions that will certainly arise in the future on this subject.

Aluminum in Alloys of Copper

We are making castings of the following formula: Copper, 88 per cent; tin 9 per cent; nickel 2 per cent, and aluminum 1 per cent. Please advise the proper way to melt this alloy as we seem to have heavy losses with it; also state which metal weakens the most by heat.

The aluminum is the cause of the heavy losses and if it is to be retained, the mold must be gated and poured the same as for aluminum bronze, which means that every precaution will have to be taken to enter the metal in such a manner there will be no agitation of the flowing stream. Should the customer insist on this formula, it will be necessary in justice to yourselves to increase the price to cover the losses, for there is no doubt that considerable production loss will have to be taken. The mixture has nothing to recommend it over a straight bronze, and if it is possible to do so, discard it and substitute the following alloy which is stronger and also clean running.

BRONZE MIXTURE

	Per Cent
Copper	88
Tin	9½
Lead	½
Zinc	2

First, place two ounces of phosphor copper in the bottom of the crucibles, then the cold copper on top and melt, using charcoal as a covering. When the white metals are added, stir thoroughly.

Mixtures Suggested for Plumbing Sundries

We desire to obtain the most suitable formula for casting plumber's brass soldering nipples, also for similar brass work to be used in soil pipe fittings such as screwed clean-outs, etc. Also is it possible to melt this alloy in the cupola? We are in competition with prices that indicate it will be impossible to use the cheapest brass mixture and make it in a pit or other crucible furnace. As a large amount of this competition is from the United States side of the line and we are in Canada we will be glad to have you advise us in regard to the matter.

One of the best mixtures for making ferrules and kindred goods, because it is the cheapest and the most easy to run into thin castings without loss is the following alloy:

MIXTURE FOR BRASS FERRULES

Copper	54 pounds	11 ounces
Zinc	40 pounds	0 ounces
Lead	5 pounds	0 ounces
Aluminum	0 pounds	5 ounces

This metal will run ferrules without the necessity of getting it so hot it will smoke strongly as the aluminum imparts fluidity. On account of the high lead content for such an alloy, it will be necessary to mix it thoroughly by vigorous stirring with a pumping motion.

This alloy can be melted in a cupola, but it will cost more than to use a regular brass furnace, because the white metal part would have to be melted separately and the copper from the cupola would have to be tapped onto it, then the admixture would require to be poured from ladle to ladle several times to mix it, when it would be too cool to pour ferrules. If the ingot is made and melted in the cupola the zinc loss will ensure the ruin of anyone attempting it. Melt the alloy in a tilting brass furnace, pour into small ladles and carry off. Then if molding machines are used the castings should roll out of the sand like new dollars.

Bronze Mixture for Motor Bearings

We desire to obtain a formula suitable for a high grade bronze used in high speed motor bearings, an alloy that will outwear any other ordinary bronze. This alloy must be easy to cast, have a good color when cast, and it must machine easily as time must be saved in machining. Therefore, a quick, machining bronze is wanted.

As we interpret this inquiry, a nice easy-to-machine alloy is wanted regardless of its suitability for high speed bearings. Also, the castings must have a good color when taken from the sand. The easy-to-machine requirement can be combined with good bearing qualities in the following alloy.

KEY METAL MIXTURE

	Per cent
Copper	80
Tin	10
Zinc	5
Lead	5

Owing to the high content of tin, this alloy will not come from the sand with a good color. It will not possess the orange and yellow shading into green coloration that characterizes the red brass alloys, but it will not be unpleasing, because it will not come black unless iron is put into it. If the color is all-important the following alloy should be used, regardless of its bearing qualities:

STEAM METAL MIXTURE

	Per cent
Copper	88.50
Tin	5.50
Zinc	3.50
Lead	2.50

Pouring Copper Castings in Green Sand

Will you kindly inform us if every copper and bronze alloy can be poured with good results in green sand molds, and especially phosphor bronze containing up to 0.5 per cent phosphorus.

Whether a green sand mold can be used and give good results in the case of copper or its alloys will depend largely upon the size and character of the contemplated casting. The most important factor is the grade of the molding sand in the case of weighty castings. If the sand is of fine grade and suited for the production of small castings, a casting ranging from 50 pounds upward can be made safely only by using a facing that will guard against scabbing and cutting the mold surface, and by surface drying of the mold. But, if the sand is selected for its fitness for the especial casting to be made, there is no reason why green sand cannot be used. Thus large bushings of 1200 pounds weight have been made successfully in green sand. The smaller castings either of copper or bronze are seldom made in dry sand molds, or in skin dried molds.

Phosphor bronze containing from 0.3 phosphorus upward also are made in green sand molds, but with this extremely liquid alloy, it is necessary to be skilled in determining the pouring temperature, as the alloy is poured cool, the pouring ladle being under constant observation until the change of the surface of the molten metal occurs that denotes the proper pouring temperature. If poured before this moment the castings, whether small or large will be so rough that in most cases they are ruined. When the proper pouring temperature of the bronze is not known with certainty, it is advisable to make the molds in dry sand and to coat them before drying with a plumbago wash to keep the bronze from sinking into the sand. Such phosphor bronze castings as gear blanks weighing from 75 pounds upward are made in the United States in permanent molds, the copes being of green sand and made by machine.

THE FOUNDRY

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Theory Needs Practical Application

EUGENE GRACE, president of the Bethlehem Steel Co., during the course of a recent interview is credited with a statement that young engineers and other college graduates are of practically little use to an employer until after they have had a few years actual operating experience in the hard old mill of business. His opinion is worthy of consideration, since he has been for several years in a position where he has had an opportunity to note the development of many young men from all classes and along all lines. His company, perhaps as much as any other has encouraged individual effort and initiative in its employes, by recognition through promotion and bonus. In that manner it has provided a constant incentive to each employe to give his best effort to the interests of the company.

Further, his opinion is worthy of consideration in that he is a living exponent of his own doctrine. Although a graduate electrical engineer from a prominent eastern university he entered the Bethlehem plant a few years ago as a laborer in the billet yard. He showed more intelligence than the remaining members of the gang, so was promoted to the job of craneman in the same yard. Here he applied some of his theoretical knowledge, tempered by practical experience in handling billets. He introduced improved methods of routing material. His work attracted the attention of those who sit in high places and in a short time he also was called upon to occupy a similar position. His title no longer is superintendent of transportation, but his work still is moving material. Reduced to its last analysis, his job is that of attending a machine called the Bethlehem Steel Co., into which the raw material is fed at one end and out of which it comes at the other end in the shape of finished product.

While it is true that all young graduates are not alike and many are willing temporarily to submerge their desire for responsibility and an opportunity to direct the work of others, still a natural reluctance to engage in actual bodily labor is almost universal. Their instruction has tended to impress upon their minds the importance of knowing the why and the wherefore of various fundamental principles connected with the engineering profession, but the problems involved in actually handling the material even under normal conditions frequently is minimized.

So long as men are plentiful and peaceful, so long as the order book is filled comfortably, so long as the railroads function smoothly in delivering and removing goods from the plant, an organization will run along on its own momentum for a considerable period even if there is no genius with his hand on the wheel. However, these ideal conditions do not obtain for any extended period. Strikes, fires, and accidents beyond control have a way of manifesting themselves with disconcerting frequency; competitors devise means of increasing production, reducing selling prices and otherwise increasing their magnetic attraction for available business. Those are the occasions when a man with an intimate knowledge of the practical and theoretical phases of his job will be able to hold his team on their feet, swing them around dangerous corners, avoid collisions either from in front or behind. Here he will prove his right to hold a position where he is in control of the activities of a small or large number of men in an industrial plant.

Trade Outlook in the Foundry Industry

AUGUST is regarded as a transition period in many lines of commerce and industry. The effect of the seasonal change is more marked in retail sales, in textile and leather manufacturing, but it also is apparent in those industries allied, or contributing to the production and fabrication of metals. Automobile builders choose that month for introducing new models and orders for castings which have their origin in this source commonly do not make their appearance in the foundries until later in the fall. The month is notoriously unproductive of jobbing foundry business.

Expect Improvement

The past month has proved no exception to the rule. The tonnage of iron melted has been lighter than that of the previous month, although a general slump such as sometimes is experienced, failed to occur. That foundries in general are cheerful and expect a larger volume of business in the fall, is indicated by a revival in purchases of both iron and coke, and by a tendency to increase the stocks of materials on hand. Labor conditions are easier and the inquiry for castings in practically all lines is strong. The busy season in boiler, furnace and radiator work is at hand, and the foundries making this class of work have come through the summer with an unusually high average rate of operation. Malleable foundries, which during July averaged about 57 per cent of capacity, expect a higher production in the early fall. Automobile and railway castings, together with electrical malleables are being booked steadily, but the demand from textile machinery lines has dropped away, due to the slowing down of manufacture, particularly among the mills making cotton fabrics.

Prices of Raw Material for Foundry Use

CORRECTED TO AUG. 23

Iron		Scrap	
No. 2 Foundry, Valley	$26.00	Heavy melting steel, Valley	$16.50 to 16.75
No. 2 Southern, Birmingham	23.50 to 27.00	Heavy melting steel, Pitts.	18.50 to 19.00
No. 2 Foundry, Chicago	27.00	Heavy melting steel, Chicago	16.25 to 16.75
No. 2 Foundry, Philadelphia	25.76	Stove plate, Chicago	16.50 to 17.00
No. 2 Foundry, Buffalo	25.00	No. 1 cast, Chicago	21.00 to 21.50
Basic, valley	25.00	No. 1 cast, Philadelphia	20.00 to 21.00
Basic, Buffalo	24.00 to 24.50	No. 1 cast, Birmingham	19.50 to 20.00
Malleable, Chicago	27.00	No. 1 cast, Buffalo	19.50 to 20.50
Malleable, Buffalo	25.00	Car wheels, iron, Pittsburgh	19.50 to 20.50
Coke		Car wheels, iron, Chicago	19.50 to 20.00
Connellsville foundry, coke	5.25 to 5.75	Railroad malleable, Chicago	20.50 to 21.00
Wise county foundry, coke	7.00 to 7.50	Agricultural mal., Chicago	18.00 to 18.50
		Malleable, Buffalo	20.00 to 21.00

Sustain High Rate

Although July showed a slight decline in the manufacture of all classes of automobiles, the total of 318,000 estimated by the National Automobile Chamber of Commerce as the month's output was only 15 per cent below June and it exceeded with the exception of the preceding four months, any previous month recorded. Compared with July, 1922, a gain of 29 per cent is shown and July, 1923, established a new high record for the seventh month's output. Further, the weekly trend was upward, the last two weeks showing a gain over the first two weeks of July, 1923. Sales by dealers show little loss. Farmers are more actively in the market with the harvest season at hand, but buying still is heavier in the industrial sections. Manufacturers of automobiles already are making plans for increased production for next year and a few castings contracts calling for increases have been made. Indications point to an output of more than 4,000,000 automobiles of all classes during the present year. Sales of trucks are improving.

Steel Orders Decline

According to the department of commerce, the booking of steel castings registered a decided drop in July. Based on reports from companies representing about two-thirds of the total commercial castings capacity of the country, July orders totaled only 52,066 tons, compared to 84,878 tons, the production listed for June. This gives a tonnage which represented only 53.7 per cent of the capacity of the plants reporting. The decrease was most notable among the railway steel castings foundries, which in June showed bookings to a total of 111.7 per cent. In July this dropped to 43.7 per cent. Miscellaneous jobbing castings reflect the slowing down in railway orders which was noted during July and is attributable to delayed deliveries due to full order books as much as to any one single factor. Railway repair shops and car and locomotive building plants are operating at full schedule, while the heavier traffic incident to western grain shipments and industrial activity with increased railway earnings alike promise further buying of railway equipment. Building operations have dropped away, as was expected earlier in the season and the effect is noted in the lessened demand for building hardware, soil pipe and sanitary ware. Foundry operations noted in a report compiled by the Ohio State Foundrymen's association averaged 85.32 per cent of normal during July, giving an increase in the operating rate of about 4 per cent for all classes of shops.

Nonferrous Operations

Brass foundries encountered a falling off in orders during August, particularly those specializing in plumbers' goods. However, the demand from automotive lines, electrical goods and domestic machinery manufacturers was well sustained. Prices on nonferrous metals based on New York quotations in the *Daily Metal Trade* of Aug. 23, follow: Casting copper, 13.85c; electrolytic copper, 14.00c; Straits tin, 40.12½c; lead, 6.75c; antimony, 7,62½c to 7.75c; aluminum, No. 12 alloy, open market, 22.00c to 23.00c. Zinc on that date was 6.50c, E. St. Louis, Ill.

Comings and Goings of Foundrymen

JAMES B. CRAIG, who has taken the position of foundry superintendent for the Charles Walmsley Co., (Canada), Ltd., Longueiul, Que., as was noted previously in THE FOUNDRY, served his apprenticeship with the Fullarton Co., Paisley, Scotland. For the past 20 years, Mr. Craig has been identified with the foundry industry in America, holding executive positions with the Stewart & Peterson Co., Burlington, N. J., Buffalo Foundry & Machine Co., Buffalo, John Deere & Co., Moline, Ill., and the Toronto, Ont., plant of the General Electric Co.

J. J. Murphy has accepted a position in the sales department of Orton & Steinbrenner Co., Chicago.

Harry J. and Charles J. Dockray have started a new brass foundry at Zanesville, O.

Frank Schutz has been made foundry superintendent for the recently organized Public Service Brass Corp., Los Angeles, Cal.

J. R. Stuart, recently appointed sales representative for the Standard Tank Car Co., New York, formerly was sales engineer for the American Steel Foundries, New York.

G. L. Lee has been made foreman of the gray iron foundry of the Lenoir Car Works, Lenoir City, Tenn., while Charles Burnes, who has held that position for several years has been placed in charge of the brass foundry.

Peter G. Vanderput for 11 years superintendent of the foundry at the Ford Motor Co. plants at Highland Park and at River Rouge, Mich., recently resigned to enter the mercantile brokerage business, handling foundry supplies and other lines.

J. T. Kaukman has resigned his position as secretary and treasurer of the Ohio Steel Foundry Co., Lima, O., and will devote his entire time in the future to the affairs of the Vapo Stove Co., Lima, of which he is president. He retains his financial interest in the Ohio company, however.

Dr. Percy Longmuir has resigned as director of research of the British Cast Iron Research association on account of a serious breakdown in health. Dr. Longmuier will not formally give up his office until Nov. 1, at which time his successor will be appointed. In the meantime a bulletin detailing the research work he has carried out for the association will be published.

J. Ramsey Speer has been made president and treasurer of Mackintosh-Hemphill Co., Pittsburgh, succeeding George S. Macrum who resigned recently. Mr. Speer was identified with the organization of the present Mackintosh-Hemphill Co. which is a combination of the old firm of that name with the A. Garrison Foundry Co., Pittsburgh, the Pittsburgh Iron & Steel Foundries Co., Midland, Pa., and the Woodard Machine Co., Wooster, O. Previously Mr. Speer was chairman of the board of the Pittsburgh Iron & Steel Foundries Co. He was born in Pittsburgh in 1870, was graduated from the Massachusetts Institute of Technology, Boston, and has been active in the industry since he left college. Mr. Speer's ancestors, Joseph McClurg and William McKnight, started the Pittsburgh foundry in 1803, the first foundry built west of the Allegheny mountains. This later became the A. Garrison Foundry Co., one of the units in the present Mackintosh-Hemphill Co. Mr. Speer's father was one of the founders of the Shoenberger Steel Co., Pittsburgh, now a plant of the American Steel & Wire Co.

James B. Craig

Will Extend Courtesies to Foundry Tourists

"Compagnie Sullivan, 18 Avenue Parmentier, Paris XI, a branch of the Sullivan Machinery Co., Chicago, has extended a special invitation to visitors to the International Foundry Congress & Exhibition, to call at its headquarters. Eugene J. Rossback and E. E. Miller, manager and assistant manager respectively, are old members of the American Sullivan organization. The Paris office maintains branches at 8 Boulevard Anspach, Brussels; 26 Rue Es-Sadikia, Tunis, Tunisia, North Africa; and at 10 Rue Cavaignac, Algiers, Algeria, Africa. The Sullivan representative in Spain is Don Gumersindo Garcia, 10 Barbara de Braganza; In Italy, Ing. Mario Axerio 4 Corso San Martino. A separate organization is maintained in London under the management of Austin Y. Hoy, and A. F. Belding, with offices in Salisbury house.

Sand Company Director

John D. Cronenweth, president of the Great Lakes Distributing Co., Detroit, producers of foundry sands, recently has been elected a director of the Lancaster Coal and Sand Co., New Lexington, Ohio. The Great Lakes Co. will handle the molding sand output of the latter firm.

The Public Service Brass Corp., Huntington Park, Los Angeles, Cal., has been organized to manufacture waterworks, gas and plumbers brass castings. William F. Schultheiss is president; W. N. Dill, vice president and sales manager; and Herman M. Schultheiss, treasurer. Frank Schultz is foundry superintendent.

Program Comprehensive

An unusual group of papers on foundry and related subjects has been prepared for the consideration of those attending the international foundrymen's congress in Paris during September. In addition to those papers which will be given in English, a complete list of which appeared in THE FOUNDRY of Aug. 15, the following will be presented at the sessions held in French:

A Study of Aluminum Bronzes, by M. Brizon, Establissements Brizon, Courbevoie, Seine, and M. Galibourg,

chemist, Establissements de Dion Bouton, Puteaux.

Making American Malleable Castings in Europe, by M. Gailly, Etabl. Gailly, Charleville, Ardennes.

Methods of Testing Castings, by M. Ledesert, Compagnie de Fives Lille pour Constructions Mecaniques & Entreprises.

A Rational Method of Constructing Patterns, by M. Le Bouteiller, engineer, 13 Rue de Billancourt, Paris.

The Devastation and Reconstruction of the Foundries in the Liberated Regions, by M. Lely, consulting engineer, Boulevard Flandrin, Paris.

Malleable Castings, by M. Pascal, engineer, Le Cambon-Feugerolles.

Electric Furnaces, by M. Perrin, manager, Ste d'Etuteds Metallurques & d'Installations Industrielles, Paris.

Results from Mechanical Testing of Castings, by M. Seigle, professor, Institute of Metallurgy & Mines, Nancy.

The Foundry Leader's Task, by M. Thomas, foundry manager, Establissements Les Fils de A. Piat & Co., Soissons.

Metal for Machinery Castings, by M. Pisek, professor, Ecole Polytechnique Tcheque de Brno and president of the Association Technique de Szecho-Slovakia.

The Fatigue Limit of Cast Iron, by Jaime Coll, lieutenant colonel, Spanish army, Seville, Spain.

A Nomenclature for Foundrymen, by M. Lamoureux, manager, *La Revue Belge de Fonderie*, Liege.

Standardizing Foundry Costs, by M. Masson, secretary, committee on costs, Belgian Foundrymen's association.

Report on Malleable Castings, Belgian Foundrymen's association, by M. Piedeboeuf, foundryman, Liege and M. Remy, foundryman, Herstal-les-Liege.

Report of Committee on Apprenticeship, Belgian Foundrymen's association, by M. Varlet, manager, stablissements d'Espárance Longdoz, Liege.

The Graphitization of Cast Iron, by C. Adamson, engineer, Sheffield.

The Necessity for Standardizing Molding Sands, by H. Holmes, Newcastle-on-Tyne.

General Arrangement and Maintenance of American Foundries, by H. M. Lane, H. M. Lane & Co., Detroit.

Take Over Plant Vacated in Canadian City

The Charles Walmsley Co., (Canada) Ltd., has taken over the plant recently vacated by the Armstrong-Whitworth Co., at Longueil, Quebec, and will manufacture paper pulp machinery, hydraulic, electric, marine and general engineering castings in gray iron, steel, and brass, on an extensive scale. The parent concern, Charles Walmsley and Co., Bury, Lancashire, England, has been in business over forty years, and are famous as being the makers of one of the widest paper making machines ever constructed, the rollers being 234 inches long. Others of their specialties are Pelton wheels, and canal lock gates to accommodate ships of any tonnage.

Officials of the new company are; Harry Kay, vice president and general manager, D. Haig, secretary-treasurer, James Craig, foundry manager, and S. Entwisle, foundry superintendent.

Scientists Advance the Electrical Industry

The General Electric Co., Schenectady, N. Y., has published its history for the past 30 years, on the occasion of the retirement of Charles A. Coffin from the leadership of that company. In 1893 when Mr. Coffin began his service with the company the capital stock of the company was about $35,000,000. In 1923 it was approximately $184,000,000. In the same period the total annual sales increased from $12,000,000 to $243,000,000. Absorbing the pioneer companies, the Edison General Electric Co. and the Thompson-Houston Electric Co., the General Electric Co. has exerted a marked influence upon the development of electrical equipment.

The research of the General Electric Co. added an important contribution to the steam and hydraulic turbines for the generation of electric energy. One of the latest steam turbines manufactured has a rated capacity of 80,000-horsepower. The castings and machinery for these giant turbines as well as for most of the company's other products are made at its numerous plants.

The efforts of the General Electric Co. have influenced the application of electric power on the sea, in transportation, and in manufacturing. Since 1914 it has built, or is building, the propulsion machinery for 400 ships, including 322 merchant cargo carriers of from 600 to 900 tons each. It also has been engaged in the electrification of railways, one of which is electrified for a length of 850 miles. The company has developed electric motors ranging in size from 1/200 to 30,000-horsepower. Without the corps of scientists whose services it enjoys or has enjoyed, including Prof. Thomson, Thomas Edison, Dr. Steinmetz, Dr. Whitney, Dr. Coolidge, and Dr. Langmuir, it is probable that such progress in its various fields of endeavor could not have been made.

Add to Research Fund

The local committee which had charge of the entertainment features of the Cleveland convention of the American Foundrymen's association, having $600 left over of the fund raised by foundrymen and equipment manufacturers of Cleveland, voted to present it to the American Foundrymen's association to be administered to the original fund given by Cleveland foundrymen for use in research work.

At the board of directors' meeting on June 19 the following resolution was adopted in recognition of the gift of the Cleveland committee:

Whereas. The Foundrymen's committee of the city of Cleveland, through whose efforts the members and guests of the American Foundrymen's association were so splendidly and hospitably entertained in convention, April 28 to May 3, 1923, has tendered the balance remaining in its entertainment fund, amounting to $660.87 to the American Foundrymen's association to be used for research work;

Be it resolved, that this sum be accepted in the same generous and wholehearted spirit which prompted its offer for the purpose for which it is intended.

Be it further resolved, that this fund shall be combined with the fund contributed by a Cleveland foundrymen's committee following the 1916 convention, now amounting with interest to $427.39, into a fund which shall be known as the Cleveland research fund of the American Foundrymen's association and that the board of directors of the American Foundrymen's association on behalf of the membership at large extend its sincere thanks to the Cleveland foundrymen's committee for this gift and the secretary be instructed to convey to the members of the Cleveland committee and to each subscriber to the Cleveland entertainment fund a copy of these resolutions.

Automatic Cut-off Limits Compressor Speed

A feature of a new model air duplex compressor produced by the Ingersoll-Rand Co., New York, is an automatic cutoff governor which regulates the compressor. It is operated by oil pressure governed by the speed of the compressor. When the speed is great enough to create sufficient oil pressure, it forces a plunger up, a pilot valve opens and prevents any further lifting of the plunger until an additional increase in speed occurs. The resulting action controls the position of the cut-off valves

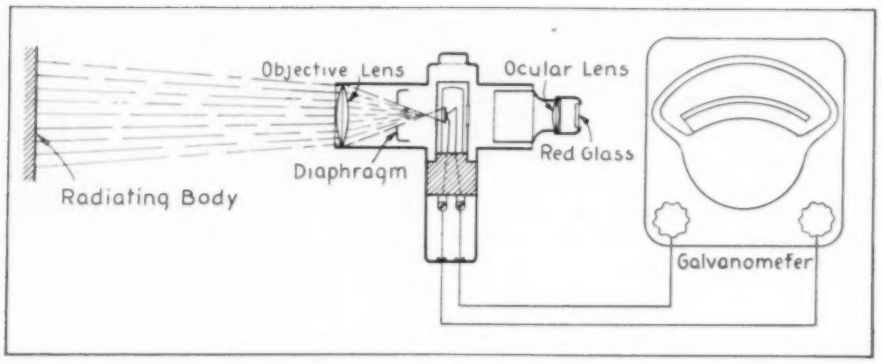


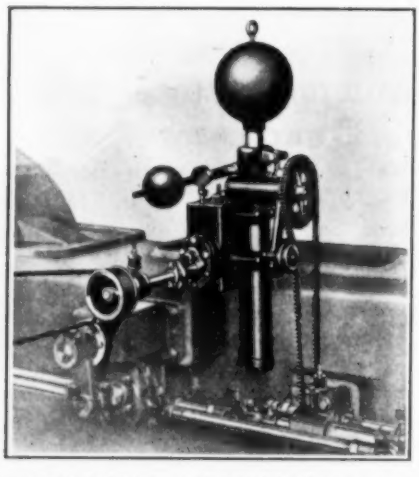
DIAGRAM SHOWING CONSTRUCTION OF THE NEW RADIATION PYROMETER

and regulates the air pressure in the receiver keeping constant.

The manufacturers call particular attention to the steam valve gear used on the compressors which consists of balanced piston valves with riding cut-off governor valve which telescope within the main valves. This gear is designed to operate under any commercial steam pressure or degree of superheat and with economy when used with ordinary saturated steam.

The other features of design which characterize this type are plate air valves and a flood system of lubrication. Different types of the compressor are made by the manufacturers to meet any peculiar or local condition of a foundry or manufacturing plant.

Because of its valves the manufacturers claim that this compressor can operate at 200 pounds pressure, 1000 degrees Fahr. superheat, and with a 25-inch vacuum. Inasmuch as the amount of air consumed generally varies during the operation of a plant, the compressor because of the governor will only operate at the rate necessary to keep the pressure constant and one-third or one-half of the rated capacity may be drawn conveniently. An automatic safety stop is provided which shuts off the supply of steam when the rotative speed exceeds that for which the compressor is designed.



AUTOMATIC CUT-OFF GOVERNOR

Develops New Radiation Pyrometer

The Bacharach Industrial Instrument Co. Pittsburgh, has put on the market a new radiation pyrometer consisting of a telescope with objective and occular lens, between which a small thermocouple is located, enclosed in a sealed glass bulb. The hot junction of the thermocouple is soldered to a thin blackened platinum disk. The free ends are connected to either an indicating or a recording instrument. This may be understood from the diagram in the accompanying illustration.

When in use the instrument is sighted directly on the incandescent body, and the total radiation of a definite area of the body is concentrated upon the blackened disk by the objective lens. This rapidly heats the small couple and the temperature is quickly indicated on the scale of the instrument. Standard scales reading up to 2200, 2600, 3000, 3300, 3700, 4000 and 4600 degrees Fahr. are available. On account of the small electromotive force generated lower scales are not provided.

To adjust the instrument for any one of these scales a diaphram is provided just behind the objective lens, and the position of this diaphram cannot be changed after calibration. All thermocouples calibrated for the same range are interchangeable because they generate the same electromotive force.

The operation of the instrument is a simple matter. The radiation receiver can be permenantly installed or used as a portable instrument. After being properly connected to the indicator, or recorder, it only has to be sighted on the glowing object so that black platinum disk, as seen through the ocular lens, is entirely covered and surrounded by radiation. This is easily distinguished by the operator.

The instrument is calibrated for black body radiation and therefore will give correct temperature readings if sighted into a furnace through an open door or through a peep hole. When using a peep hole it is necessary to protect the instrument from the flame of the furnace. For this purpose a blind end fire clay tube may be inserted in the hole protruding into the furnace and the instrument may be sighted on the bottom of the tube. In such cases the pyrometer is mounted on the open end of the tube and may be placed in a simple iron pot to guard against injury.

Builds New Single Spindle Borer

A motor-in-head, vertical and single spindle wood borer has been designed by the Oliver Machinery Co., Grand Rapids, Mich. In this model the driving motor is mounted directly on the spindle of the boring machine, the motor itself having no bearings. By this construction belting, countershafts, pulleys and many bearings are eliminated. A special feature emphasized by the manufacturers is a blower mounted directly on the spindle at the top of the machine to keep the work free from dust or borings. The distance from spindle to column is 18 inches and the vertical movement of the table is 14 inches. As a result the boring machine is capable of handling large patterns. It will cut up to 2 inches in diameter and 6 inches deep with one stroke, to the center of 36 inches. The table, as shown in the accompanying illustration, swivels completely around and tilts up to 45 degrees in any direction. The motor is completely enclosed and is designed for either 220 or 440 volts, runs at the rate of 3600 revolutions per minute on 60 cycles and 3000 on 50 cycles.

DRIVING MOTOR IS AN INTEGRAL PART OF THE BORING SPINDLE

Dullness Holds Back Orders

Lack of Interest in New Equipment Accompanies the Late Summer Slack in Foundry Operations—Prices Remain Firm—Optimism Expressed for Fall Outlook

CONTINUED apathy is noted in the foundry equipment market, although foundry operations have held an unusually high summer average. In spite of this slack the General Fire Extinguisher Co. has closed a contract for a sand handling system to be constructed by the Chain Belt Co., Milwaukee. The Great Western Smelting & Refining Co., San Francisco, is planning to erect a foundry. The Shanghai I Feng Enamel Co., Ltd., has been granted incorporation papers by the Chinese ministry of agriculture at Pekin, China. The Dominion Engineering Co., Lachine, Que., Canada, is contemplating foundry extensions to accommodate work at present jobbed to other foundries. Morris Cahill is foundry superintendent. The Hays Brass & Aluminum Co., Michigan City, Ind., has been incorporated by Joseph W. Hays and Phillip T. Sprague of Michigan City with Alva F. Orcutt and Robert B. Jones of Laporte, Ind.

Interest Light in Eastern Market

ONE project likely to come up soon is a $200,000 foundry to be erected by Shamrock Propellers Co., Seattle, Wash., at Norfolk, Va. The plant of the Myerstown Foundry & Mfg. Co., Myerstown, Pa., recently badly damaged by fire will be rebuilt, as soon as plans can be completed. Included in recent orders is a cupola for the Bassich Co., Meriden, Conn., this business going to the Whiting Corp., Harvey Ill. Recent sales of sand blast and dust arrester equipment by the Pangborn Corp., Hagerstown, Md., include units for the Maryland Brass & Metal Works, Baltimore, Eclipse Machine Co., Elmira, N. Y., American Laundry Machinery Co., Rochester, N. Y. and American Radiator Co., Buffalo. The Amherst Foundry Co., Amherst, Nova Scotia has purchased a sand blast installation and dust arrester equipment; the Hunt-Spiller Mfg. Co., Boston, tumbling mills and the Worthington Pump & Machinery Corp., East Cambridge, Mass., tumbling mills and dust arrester equipment from the W. W. Sly Mfg. Co., Cleveland.

Summer Brings Little Pittsburgh Business

REPLACEMENT orders for foundry equipment in the Pittsburgh district still are light, with little evidence displayed toward recovery from the mid-summer dullness which has surrounded the market during the past six to eight weeks. However, in the face of the quiet which prevails, sellers of foundry equipment are not tinkering with the prices. During July sales of foundry supplies declined about 30 per cent as compared with transactions recorded in June, but during the past two weeks a few sellers state that the supply market has staged a slight comeback. No sizable buyer of foundry equipment is in the market as far as can be ascertained and about the only sale reported involves a sand cutter. The structure of the market is well supported and equipment sellers entertain hope that the reluctance on the part of buyers will undergo a change when next quarter opens. Close observers point out that a change toward the constructive side of the market usually originates in the east and the renewed interest of buyers of foundry products in that district the past three weeks leads representatives of equipment makers to forecast a pick-up in demand for equipment. The Lebanon Steel Foundry Co., Lebanon, Pa. has purchased sand blast and dust arrester and the American Sterilizer Co., Erie Pa., sand blast equipment from the Pangborn Corp., Hagerstown, Md.

FOUNDRY equipment throughout the Central West continues to move in fair volume. However, many manufacturers report no marked increase in sales in August as compared with July. Cupolas, especially in the smaller sizes, recently have been in more pronounced demand. The Ford Motor Co., Detroit, ordered two more cupolas from the Whiting Corp., Harvey, Ill., and this same builder has placed several additional cupolas with scattered foundries. Two buyers were eastern melters. The Pettibone, Mulliken Co., Chicago, has been in the market during the past week for considerable miscellaneous material including a jib crane, ladles and flasks. The American Sash Weight Foundry Co., Davenport, Ia., has also been a fairly active buyer. Large crane sales for foundry use were dull throughout August but small cranes sold in fair number considering the time of year.

Recent sales by the W. W. Sly Mfg. Co., Cleveland, include dust arrester equipment to the Belle City Malleable Iron Co., Racine, Wis. and the Packard Motor Car Co., Detroit; tumbling mills to the Badger Foundry Co., Racine and sand blast machinery to the Los Angeles Foundry Co., Los Angeles. The Packard Motor Car Co., Detroit, also contracted for dust arrester equipment with the Pangborn Corp., Hagerstown, Md. Sales of sand blast equipment by that company include units for the Chambers Mfg. Co., Shelbyville, Ind., the Riverside Foundry & Galvanizing Co., Kalamazoo, Mich., and Deere & Co., East Moline, Ill.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The Hays Brass & Aluminum Foundry Co., Michigan City, Ind., is erecting a foundry.

The Asheville Supply & Foundry Co., Asheville, N. C., plans extensions and improvements to its plant.

The T. A. Cummings Foundry Co., Chicago, has increased its capital stock from $40,000 to $200,000.

The Eugene Foundry & Machine Co., Eugene, Oreg., has been incorporated for $20,000 by Geo. W. Philler, Jas. McGuire and R. T. Burghardt.

Bids are being taken by the Milwaukee Steel Foundry Co., Milwaukee, for a 1-story building addition, 50x75 feet.

The Orangeburg Foundry Co., Orangeburg,

S. C., plans to rebuild the portion of its plant recenty damaged by fire.

The Keeler Brass Co., 947 Godfrey avenue, Grand Rapids, Mich., plans a 1-story factory building.

The Magoe Furnace Co., Taunton, Mass., has let the contract for a brick, 1-story 24x139-foot factory.

Part of the plant of the Myerstown Foundry & Mfg. Co., Myerstown, Pa. was recently damaged by fire.

The Lilly Foundry Co., 2272 E. 15th street, Los Angeles, Cal., has purchased a 5-acre site at Downey boulevard and E. 26th street.

R. T. Rutzen will build a brick and frame pattern shop, 50x60 feet, at 1103 Forty-eighth street, Milwaukee, at a cost of about $15,000.

The Muncie Malleable Foundry Co., Muncie, Ind., plans a 1-story molding room, 70x100 feet, to cost approximately $20,000.

The Holyoke Foundry Co., Holyoke, Mass., has let the contract for the erection of an addition.

Leominster Brass Foundry & Machine Shop, Leominster, Mass., has enlarged its foundry and plans to employ additional workmen.

The Elkhart Foundry & Machine Co., Elkhart, Ind., has been incorporated with $50,000 capital stock by William H. Patterson, Russell E. Patterson and Clarence B. Proseus.

It is reported that the Carhart Bros. Foundry Co., 1618 North Salina street, Syracuse, N. Y., is planning to remodel its foundry at an estimated cost of $20,000.

The Buckwalter Stove Co., Royersford, Pa., has awarded a contract to the Beling-Bush Co. Inc., Philadelphia, for the erection of a 3-story carpenter and pattern shop.

Damage of approximately $100,000, mostly to the pattern room, was done by fire in the plant of the Davitt Iron Foundry, Springfield, Mass.

Harry J. and Charles J. Dockray have opened their new foundry on Arthur street, Zanesville, O. They are said to be planning to enlarge the business in the near future.

The Great Western Smelting & Refining Co., 75 Folsom street, San Francisco, is planning the erection of a foundry building 137x275 feet at Spear and Folsom streets.

The S. B. Sexton Stove Corp., 501 West Conway street, Baltimore, recently was incorporated by William B. McMilian, Harold Tschudi and Mathew Gault. The company will continue an existing business.

Morton Jones & Co. is the name of a new corporation formed at Asheville, N. C. to engage in the manufacture of hot-air heating furnaces, etc. Morton Jones is president of the company.

Hayes Pump & Machinery Co., Boston, has been incorporated with $5000 preferred stock and 5000 shares of common stock without par value. Frederick E. Backus, Alfred I. West and G. G. MacDonald were the incorporators.

It is reported that the Shamrock Propellers Co., of which C. H. Boyles is general manager, is planning the erection of a foundry at Norfolk, Va. The estimated cost of the new structure is $200,000.

Incorporation with $50,000 capital stock recently was effected by the New York Brass & Iron Co., Spokane, Wash. The company is represented there by Donovan & Grant, 434, The Rookery.

Castings & Supplies, Ltd., Montreal, Canada, has been incorporated with $2500 capital and 500 shares of no par value stock by Charles R. McKenzie, Francis G. Bush, Herbert W. Jackson and others.

The Jamestown Malleable Products Co., Tiffany avenue, Jamestown, N. Y., has awarded a contract for the erection of a 1-story foundry building, 50 x 200 feet, to be built at an estimated cost of $50,000.

Capitalized at $10,000 the Vulcan Valve Mfg. Co., Cleveland, recently was incorporated by A. E. Wolfe, R. G. Dann, S. M. Orth, L. M. Wilson and Joseph Klein. The latter is an attorney with offices in the Cleveland Discount building.

Papers were drawn by A. K. Strong, R. W. Edwards, P. D. Collins, A. C. Knight and William E. Callahan, for the incorporation of the McIntosh-Donley Co., Cleveland, with $10,000 capital stock. The company will manufacture internal combustion engines.

Erection of a 3-story addition to its plant is being planned by the Lathwood Foundry Co., Pittsburgh. The addition will be 103x195 feet and will cost approximately $40,000. C. H. Dunnells, 135 Riverview avenue, Pittsburgh, is engineer in charge.

Bids are being taken by the Grimm Aluminum Foundry Co., Manitowoc, Wis., for the erection of a brick and steel casting shop with brass and aluminum furnaces. The structure will be erected at the foot of South Twenty-first street. Plans were prepared by W. J. Reuber, architect of Manitowoc, Wis.

A new 1-story 45x150-foot factory building was just completed for the A. J. Braasch Heater Co., Hollywood, Cal. Hamm & Grant, Inc., industrial engineers, 607 Ferguson building, prepared the plans for the building and carried out the construction work. The building has clear span trusses, steel sash and cement floor.

A foundry will be built by the Columbus Steam Pump Works, Columbus, O., according to plans annornced by its officials. The foundry will be of steel construction and will be equipped with a crane and other machinery. The Austin Co., Cleveland, has the general contract for the building.

Approximately $10,000 loss was sustained by the Toronto Foundry Co. plant, 1884 Davenport road, Toronto, Ont., when fire recently damaged the works. Of the total loss, $6000 was to the buildings and $4000 to the equipment. It is expected that the plant will be rebuilt immediately. Arthur Mason, 130 McRobert street, is manager.

Stockholders of the Wise-McClung Mfg. Co., New Philadelphia, O., met recently to consider plans for raising funds with which to operate the factory. The plant has been closed for several weeks. A special committee was appointed at the request of the stockholders to meet with the present board of directors and devise a plan for creating a working fund.

Incorporation was recently effected of the Mianus Diesel Engine Co., Inc., Stamford, Conn., with preferred stock of $500,000 and 10,000 shares of common stock, without par value. This company takes over the Mianus Motor Works, Inc., a $500,000 corporation. Burges Osterhout, Brooklyn, N. Y., Mark E. O'Connell and Charles F. Bailey, both of New York, were the incorporators of the new organization.

A temporary receiver, Elmer Mattern, has been named for the Wabash Foundry Co. Wabash, Ind., in the suit of the County Loan & Trust Co. N. G. Hunter is attorney for the bank which filed suit asking that the temporary receiver be named and that on hearing the receivership be made permanent. Mr. Mattern filed $25,000 bond and was authorized by the court to operate the plant until further notice.

Consolidation of the Winchester Foundry Co., with the Timmins Machine Works, Lexington, Ky., was announced recently by William Timmins, president of the latter company. Consolidation has been effected under the firm name of the Timmins Foundry Co. The Winchester Foundry Co., which is one of the largest foundries in Kentucky, manufactures gray iron and semisteel castings from one pound to 20 tons.

With a capital stock of $150,000 the Bennett Brass Co., Greenville, Mich., recently was incorporated by W. J. Bennett, president; F. C. Genge, vice president; E. C. Mangold, secretary; C. G. Kuennen, treasurer, and J. J. Siefen, general manager. The officers and J. D. Miskell and E. P. Chamberlain constitute the board of directors. The company has acquired the assets of the Regle Brass Co. and will manufacture a general line of brass goods.

The Cincinnati Enameling Co., Cincinnati, has been incorporated with a capital stock of $30,000 and has taken over the old plant of the Cisco Machine Tool Co., Cincinnati, for manufacturing purposes. Officers of the company are: Robert Heuck, president; Harry E. Johnson, vice president and general manager and Francis A. Hoover, secretary. Mr. Heuck was for many years connected with the Republic Iron & Steel Co., Youngstown, O., while Mr. Johnson was with the Cleveland Metal Products Co., Cleveland. The company will manufacture enameled parts for stove, refrigerator and sanitary supply manufacturers. The plant will be equipped with new machinery.

Approximately $1,000,000 is to be spent by the Buick Motor Car Co., Flint, Mich., on extensions and improvements and for the erection of an assembly plant. The Buick company is installing two large concrete storage tanks for oil at its forging plant at the present time. The tanks will be submerged and will measure 60 feet in length and 30 feet across, of triangular shape. Each tank will be of 20,000-gallon capacity. The company recently completed remodeling a small cupola and the erection of another one. This gives the Buick company seven cupolas all at present in operation. A sand storage house 100 x 200 feet also was recently completed.

New Trade Publications

MOTOR-DRIVEN TOOLS—A 4-page bulletin has been issued by the Stow Manufacturing Co., Inc., Binghamton, N. Y., describing its production of metal working tools for die sinking, grinding, buffing, drilling, polishing, and cleaning. Motors are furnished in all sizes from ¼ to 5 horsepower and for most voltages. All of the equipment is portable, and suspensions or pedestals are offered for special purposes.

PLATING AND POLISHING SUPPLIES—A. P. Munning & Co., Matawan, N. J., has completed an elaborate catalog, describing its line of industrial supplies and grinding apparatus. It includes grinding and polishing motors for benches or stands, automatic polishing and buffing machines, sand blast barrels, oblique or horizontal tumbling barrels, and ball burnishing or tubbing barrels. Of the 250 pages in the catalog, 125 are devoted to grinding and tumbling equipment. The feature of the sand-blast equipment as described is that the abrasive used never leaves the barrel. Tumbling barrels are illustrated either for shaking out cores or sand or for grinding or smoothing with abrasives large or small castings. Circular wire scratch brushes are recommended also for cleaning castings.

PORTABLE ELECTRIC TOOLS—The R. G. Haskins Co., Chicago, has published a 32-page catalog describing its flexible shaft equipment and portable tools. The equipment is all of the same type, but the size of motor and the type of tools are changed according to the kind of work to be done. The features of the equipment are the swivel base allowing the whole machine to rotate so that the shaft is always in alignment and the multispeed countershaft with a link belt. A complete equipment of patternmaker's tools is described, including eight file cut burrs made of high-speed steel, emery pencil chuck and pencil and grinding wheel mandrel. The burrs are made to cut pattern shop metals, and accessories for special purposes may be obtained.